

Water-Quality, Discharge, and Biologic Data for Streams and Springs in the Highland Rim Escarpment of Southeastern Bedford County, Tennessee

U.S. GEOLOGICAL SURVEY

Open-File Report 95-732

Prepared in cooperation with the
BEDFORD COUNTY SOLID WASTE AUTHORITY



Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 1995		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Water-Quality, Discharge, and Biologic Data for Streams and Springs in the Highland Rim Escarpment of Southeastern Bedford County, Tennessee				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of the Interior 1849 C Street, NW Washington, DC 20240				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 41	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Water-Quality, Discharge, and Biologic Data for Streams and Springs in the Highland Rim Escarpment of Southeastern Bedford County, Tennessee

By E.F. HOLLYDAY and THOMAS D. BYL

U.S. GEOLOGICAL SURVEY

Open-File Report 95-732

Prepared in cooperation with the
BEDFORD COUNTY SOLID WASTE AUTHORITY

Nashville, Tennessee
1995



U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

The use of firm, trade, and brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

For additional information write to:

District Chief
U.S. Geological Survey
810 Broadway, Suite 500
Nashville, Tennessee 37203

Copies of this report can be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Report Section
Box 25286, Mail Stop 417
Denver Federal Center
Denver, CO 80225

CONTENTS

Abstract.....	1
Introduction	1
Site description and hydrogeologic setting.....	2
Reconnaissance data	2
Seepage investigation data.....	7
References cited.....	36

ILLUSTRATIONS

1. Map showing location of Quail Hollow landfill, selected streams, and outcrop of the base of the Chattanooga Shale.....	3
2. Diagrammatic geologic section of the Highland Rim escarpment in southeastern Bedford County, Tennessee....	4
3. Map showing location of measurement sites on streams in the northern half of the study area, Bedford County, Tennessee.....	5
4. Map showing location of measurement sites on streams in the southern half of the study area, Bedford and Moore Counties, Tennessee.....	6
5. Graph showing conductivity of water at site 3005, near the mouth of Anderton Branch near Raus, Bedford County, Tennessee.....	8
6-8. Conductivity profiles for selected streams near Raus, Bedford County, Tennessee:	
6. Anthony Branch, February 22 and 23, 1995	22
7. Anderton Branch, March 22 and 23 and April 25, 1995	23
8. Powell Branch, November 3, 1994, and March 22 and 30, 1995	24
9. Graph showing the relation between specific conductance and dissolved-solids residue in water from Bedford and Moore Counties, Tennessee	28
10. Map with Stiff diagrams showing distribution of major constituents in water analyses from seepage investigation, Bedford and Moore Counties, Tennessee	29
11-13. Bar graphs of selected properties and water-quality constituents in water analyses from the seepage investigation, Bedford and Moore Counties, Tennessee:	
11. Specific conductance	30
12. Chloride	31
13. Dissolved manganese	32
14-16. Gas chromatography/flame-ionization detection graphs for water from the seepage investigation at selected sites, Bedford County, Tennessee:	
14. Renegar Branch, East Fork.....	33
15. Kemp's seep	34
16. Sons' Spring	35

TABLES

1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee	9
2. Reconnaissance measurements of benthic macroinvertebrate diversity and abundance at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee.....	18
3. Laboratory measurements of water quality for samples collected during the seepage investigation in Bedford and Moore Counties, Tennessee, March 22, 1995 and April 25, 1995.....	25

CONVERSION FACTORS, ABBREVIATED WATER-QUALITY UNITS,
VERTICAL DATUM, AND SITE-NUMBERING SYSTEM

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
Area		
acre	4,047	square meter
acre	0.4047	hectare
square mile (mi ²)	2.590	square kilometer
Volume		
gallon (gal)	3.785	liter
Flow		
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second
gallon per minute (gal/min)	0.06308	liter per second
Water quality		
microsiemens per centimeter (μS/cm)	1.0000	micromohs per centimeter

Temperature in degree Fahrenheit (°F) can be converted to degree Celsius (°C) in the following manner:

$$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$$

Abbreviated Water-Quality Units

milliliter (mL)
milligrams per liter (mg/L)
micrograms per liter (μg/L)
microsiemens per centimeter (μS/cm)

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Site-Numbering System: In this report, sites are identified with four-digit numbers in which the first digit designates the drainage basin and the remaining digits designate the unique site. Within a basin, site numbers increase upstream, accounting for tributaries before continuing up the main stem. Numbers are commonly separated by five in order to allow for additional sites.

Water-quality, Discharge, and Biologic Data for Streams and Springs in the Highland Rim Escarpment of Southeastern Bedford County, Tennessee

By E.F. Hollyday and Thomas D. Byl

ABSTRACT

From November 1994 through April 1995, streams and springs in 9 drainage basins were observed and sampled at 176 sites to obtain information on environmental quality near the Quail Hollow landfill, Bedford County, Tennessee. Reconnaissance data were collected to establish a regional pattern. Water samples from 26 seepage sites were analyzed to determine water-quality conditions. During the reconnaissance, conductivity ranged regionally from 17 to 617 microsiemens per centimeter ($\mu\text{S}/\text{cm}$). The greatest biologic diversity was in Bennett Branch, followed by Daniel Hollow, Prince, Powell and Renegar, County Line, and Anthony Branches, Hurricane Creek, and Anderton Branch, respectively. In general, conductivity was less than $50\mu\text{S}/\text{cm}$ at and upstream of the Chattanooga Shale but increased downstream to between 200 and $300\mu\text{S}/\text{cm}$. Of the constituents and properties analyzed, only pH and four metals at six sites had values that were not within the limits set by the State of Tennessee for drinking water. Chloride and dissolved manganese concentrations were highest for a spring and a seep adjacent to the landfill. Scans indicated the presence of about 37 unidentified organic compounds at these same two sites.

INTRODUCTION

The Bedford County Solid Waste Authority (BCSWA) currently (1995) monitors materials placed in the Quail Hollow landfill located between Shelbyville and Tullahoma, Tennessee. The landfill has been in operation since 1972 under more than one owner and, like all landfills in the State, has come under increasingly stringent regulations for the protection of environment and health. Several studies have been completed by the Tennessee Division of Solid Waste Management and consultants for local landowners or for the landfill operators regarding the environmental effects of the landfill. However, the BCSWA is concerned that previously undetected contaminants may have left the landfill and entered aquifers and streams in and around the landfill site.

A major problem in assessing the environmental effects of the landfill is that background water quality resulting from other human activities or from natural processes is poorly defined at the site. As part of continuing studies of human effects on water quality, the U.S. Geological Survey (USGS), in cooperation with the BCSWA, conducted an investigation of the quality of water in streams and springs draining the landfill and nearby properties. The purpose of this investigation was to determine regional patterns in water quality and any apparent effects caused by human activities along the Highland Rim escarpment of southeastern Bedford County.

This report presents data collected during the observation and measurement of streams and springs. Reconnaissance-level data on water conductivity,

selected dissolved solids, estimated discharge, and aquatic organisms were collected between November 1994 and April 1995 from 176 sites on 9 streams that drain the Highland Rim escarpment. Sites were related to each other by conductivity profiles, three of which are presented as examples. During a seepage investigation, water samples were collected for laboratory analysis of major ions, nutrients, selected metals, and scans for organic compounds at 26 sites on the 9 streams. The distribution of water types is shown by a map. Selected data are illustrated by bar graphs of constituents and by chromatographs of samples.

The authors thank local landowners who allowed access to measurement sites on their properties. In addition, the authors gratefully acknowledge the following colleagues in the U.S. Geological Survey who helped them collect, process, and prepare the data for publication:

R.A. Aycock	T.D. Holt
M.W. Bennett	D.E. League
A.K. Brachmann	J.F. Lowery
D.E. Butner	J.M. Shelton
F.E. Edwards	W.J. Wolfe
J.T. Hamilton	

and the following colleagues who, with the authors, formed the report review team, which expedited the report to publication:

E.G. Baker	H.C. Matraw, Jr.
B.H. Balthrop	R.L. Mitchell III
M.W. Bradley	J.A. Robinson
C.J. Davis	

SITE DESCRIPTION AND HYDROGEOLOGIC SETTING

The study area is in south-central Tennessee within southeastern Bedford County and a small part of northeastern Moore County (fig. 1). The Quail Hollow landfill is 1.9 mi north of Motlow State Community College. Land surface altitude ranges from 800 ft along northern Thompson Creek, which is in the Central Basin physiographic region of Tennessee (Miller, 1974, p. 5), to 1,100 ft along upper Hurricane Creek, which is in the Highland Rim physiographic region. The outcrop of the base of the Chattanooga Shale (Wilson, 1969, 1970) approximates the boundary between the two physiographic regions (fig. 1). Drainage basins of the following nine streams are included in the study area, from north to south: Renegar, Anthony, Anderton, Powell, Bennett, "County Line,"

Daniel Hollow, and Prince Branches, and Hurricane Creek. All but Hurricane Creek drain the escarpment from the Highland Rim in the southeast to the Central Basin in the northwest. Land use is predominantly deciduous forest or pasture.

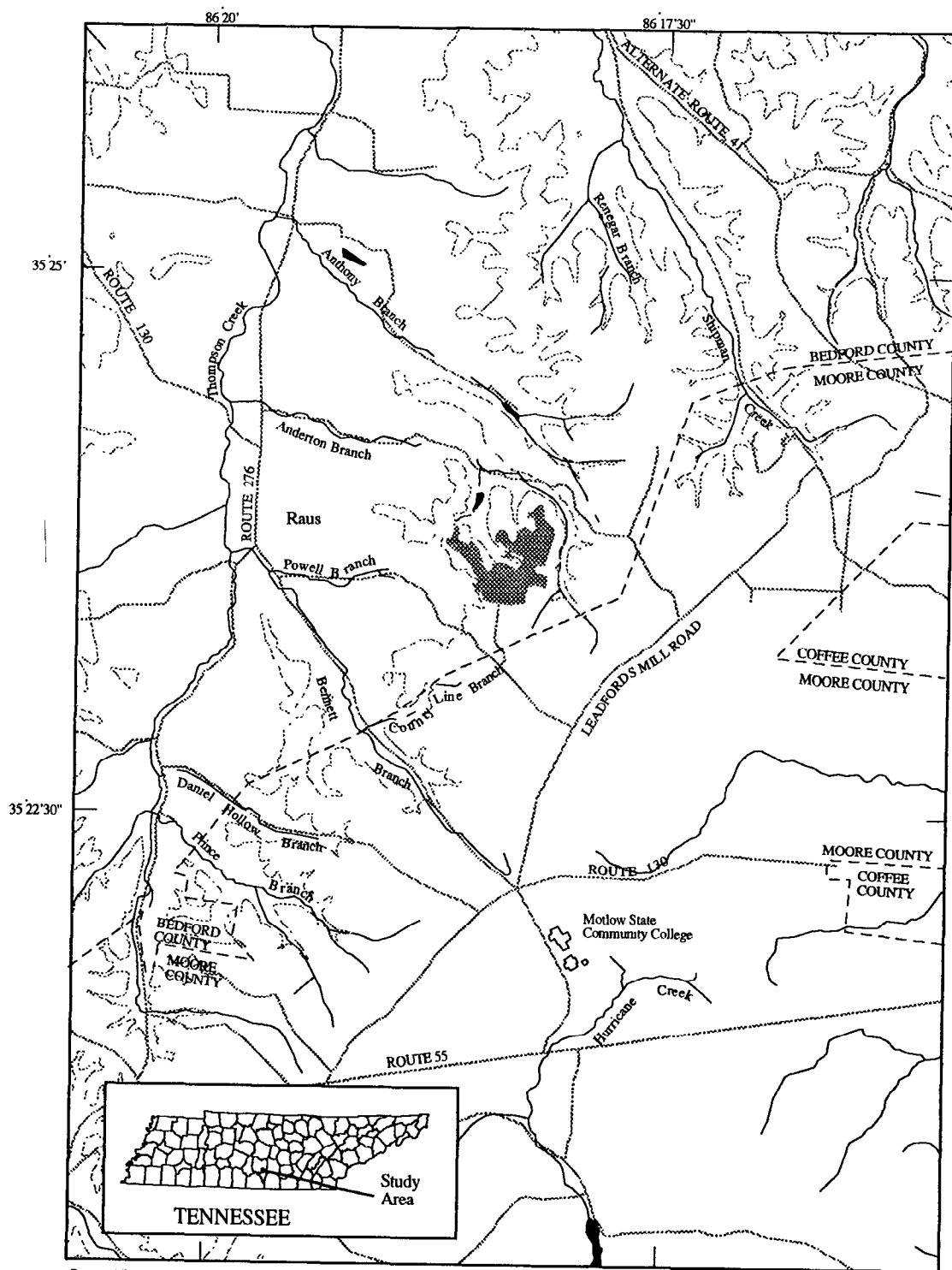
Near the headwaters of the escarpment streams, the Highland Rim is capped by cherty, clay-rich regolith and chert slabs weathered from the Warsaw Limestone and Fort Payne Formation, which overlie the Chattanooga Shale (Wilson, 1969, 1970). Underlying 20 ft of black, fissile Chattanooga Shale is a sequence of Ordovician limestone (fig. 2) consisting of thin-bedded, clay-rich limestone units which alternate with thick-bedded, clay-free limestone units. The hydrogeologic sequence is Warsaw Limestone and Fort Payne Formation (aquifers), Chattanooga Shale (confining unit), Leipers and Catheys Formations (minor aquifers), Bigby-Cannon Limestone (aquifer), and Hermitage Formation (confining unit). Several wet caves in the study area are located within either the Bigby-Cannon Limestone or the basal part of the Leipers and Catheys Formations (Gerald Moni, Cumberland Chapter, National Speleological Society, written commun., 1995).

RECONNAISSANCE DATA

Intermittently from November 1994 through April 1995, streams and springs in nine drainage basins were observed and measured. Streamflow was at base flow during all but one site visit (March 9, 1995). Headwater reaches were walked, and lower reaches were observed from farm roads. Greatest attention was given to headwater reaches in and around the landfill as illustrated by the density of sites (figs. 3 and 4).

During November 2, 1994, through February 22, 1995, and on March 21 and April 25, 1995, water conductivity, temperature, and pH were measured at the initial sites. Beginning March 3, 1995, conductivity, temperature, dissolved oxygen, pH, and infrequently turbidity were measured at the remaining sites. All meters were calibrated in the field or in the office on the day of reconnaissance using two or more laboratory standards.

Discharge was estimated as the product of the stream mean width, mean depth, and observed velocity. The abundance of aquatic invertebrates was estimated by counting all individual organisms on five rock samples of about 4-in. diameter that were picked



Base modified from U.S. Geological Survey,
1:100,000 digital line graph

Geology from Wilson
(1969 and 1970)

EXPLANATION

- QUAIL HOLLOW LANDFILL
- POND
- OUTCROP OF THE BASE OF THE CHATTANOOGA SHALE

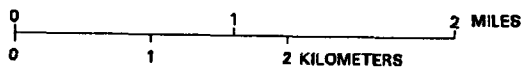


Figure 1. Location of Quail Hollow landfill, selected streams, and outcrop of the base of the Chattanooga Shale.

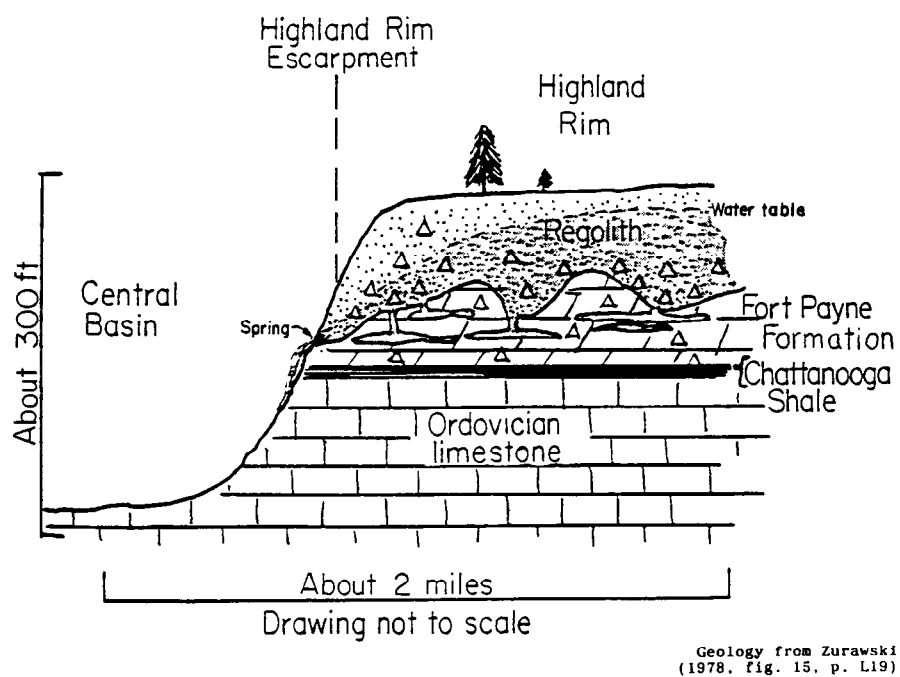
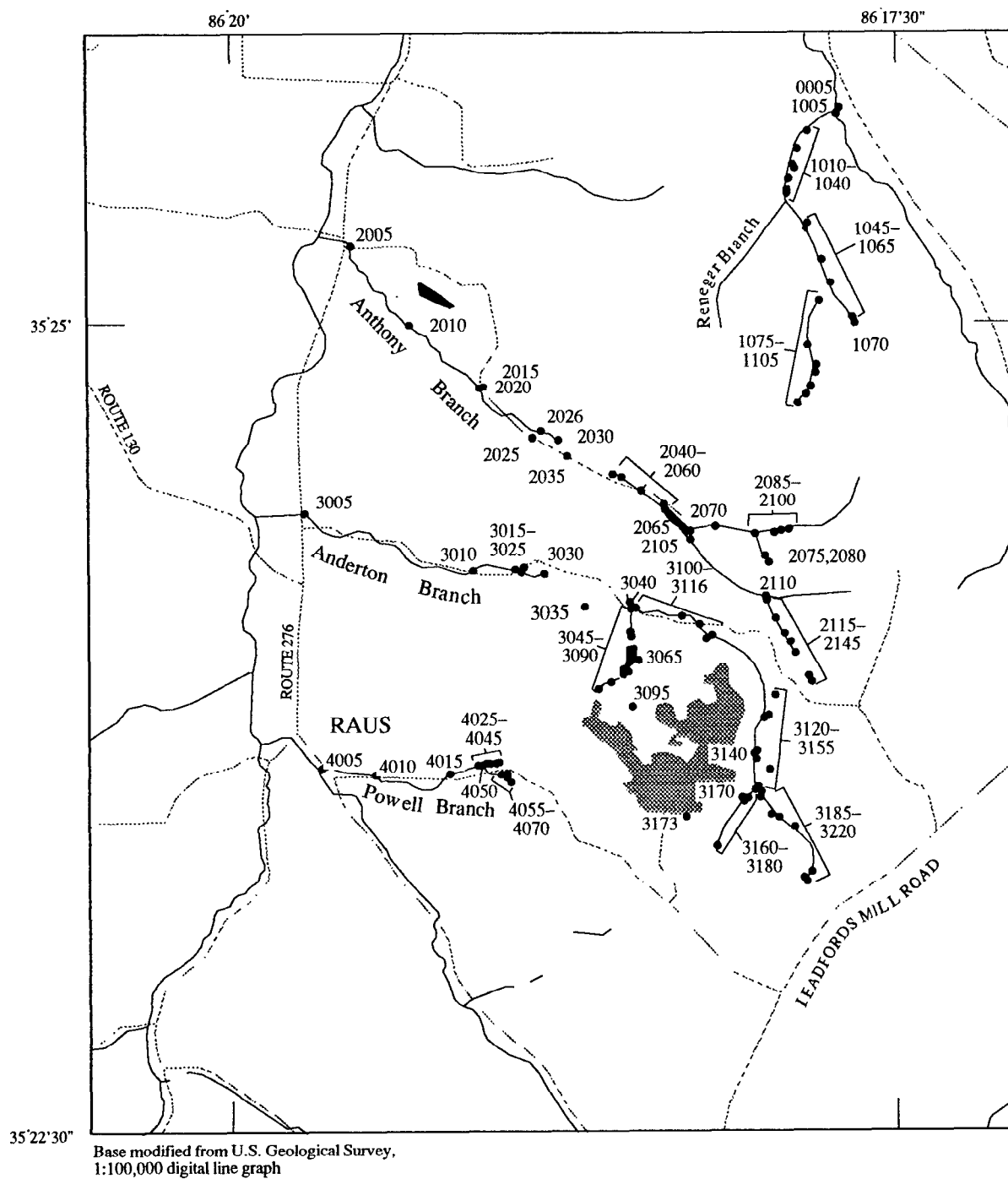


Figure 2. Diagrammatic geologic section of the Highland Rim escarpment in southeastern Bedford County, Tennessee.



EXPLANATION

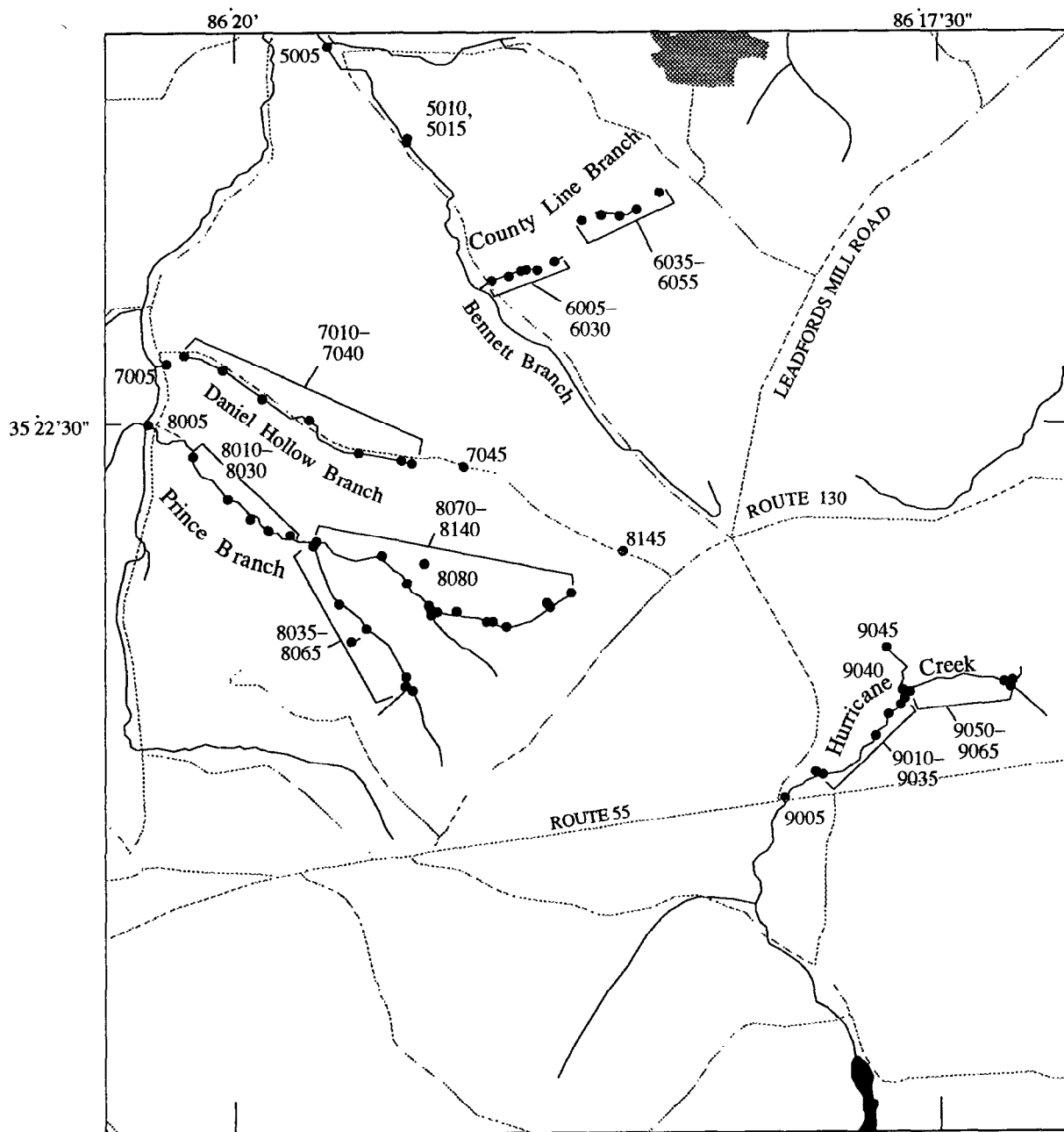
■ QUAIL HOLLOW
LANDFILL

● 1080 MEASUREMENT SITE
AND NUMBER

▬ POND

0 1 MILE
0 1 KILOMETER

Figure 3. Location of measurement sites on streams in the northern half of the study area, Bedford County, Tennessee.



Base modified from U.S. Geological Survey,
1:100,000 digital line graph

EXPLANATION



QUAIL HOLLOW
LANDFILL



POND



5010 MEASUREMENT SITE
AND NUMBER

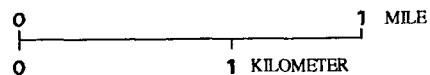


Figure 4. Location of measurement sites on streams in the southern half of the study area, Bedford and Moore Counties, Tennessee.

from the stream bottom. A 250mL sample was collected at many sites for chemical analysis of the water using a portable laboratory in the office. Calibration standards were run at the beginning and end of each analytical session. Analyses included some or all of the following: alkalinity, chloride, nitrate as N, and total iron.

Because hydrologic conditions changed during the reconnaissance period, site 3005 near the mouth of Anderton Branch was selected to monitor trends in conductivity (fig. 5). Conductivity at this site changed less than 10 percent during reconnaissance sampling with the exception of a dry period in early November 1994 and on March 9, 1995, following a storm.

The reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at 176 sites on the nine streams are presented in table 1. Conductivity ranged from 17 to 617 $\mu\text{S}/\text{cm}$, and alkalinity from 1 to 210 mg/L as CaCO_3 . The chloride concentration ranged from less than 1 to 60 mg/L . Estimated discharge ranged from 0.001 to 10 ft^3/s . The reconnaissance measurements of benthic macroinvertebrate diversity and abundance are presented in table 2. The stream with the greatest diversity of organisms per sample was Bennett Branch, followed by Daniel Hollow, Prince, Powell and Renegar, County Line, and Anthony Branches, Hurricane Creek, and Anderton Branch, respectively. The stream with the greatest abundance of organisms per sample was Prince Branch, followed by Powell, Bennett, Renegar, Anthony, and Anderton Branches, Hurricane Creek, Daniel, and County Line Branches, respectively. These biological samples were collected during winter and spring (high) base flow only and, therefore, do not provide any information on how the biological community might change over time. Additional sampling during summer and fall (low) base flow would provide information concerning the biological integrity of the streams.

Water-quality changes in the streams are indicated by the change in conductivity from upstream to downstream and from tributary to main stem. Conductivity profiles that show these changes are presented for Anthony, Anderton, and Powell Branches (figs. 6-8, respectively). In general, conductivity is less than 50 $\mu\text{S}/\text{cm}$ at, and upstream of, the base of the Chattanooga Shale (fig. 6). Conductivity increases in the downstream direction to a value generally between 200 and 300 $\mu\text{S}/\text{cm}$ near the confluence with a receiving stream (figs. 6 and 7). This pattern may be inter-

rupted and the increase accelerated where the stream goes underground along a dry reach (figs. 6 and 7).

SEEPAGE INVESTIGATION DATA

On March 22, 1995, stream discharge was measured and water samples were collected at 24 sites on 9 streams during base flow conditions. Additional sites, a spring and a seep, were sampled on April 25, 1995, in order to better define water chemistry in the headwaters of Anderton Branch, adjacent to the Quail Hollow landfill.

Discharge was calculated from measurements of width, depth, and velocity determined using a pygmy current meter, or from weirs or calibrated volumes, depending upon the quantity of flow as described in Buchanan and Somers (1969). Conductivity, temperature, and pH measurements were taken with calibrated meters. Discharge measurements were considered accurate to within 10 percent.

Water samples collected at the 26 sites were analyzed for major ions, nutrients, selected metals, and eight samples were scanned for organic compounds at the USGS Water-Quality Service Unit in Ocala, Florida. Major ions were measured in order to determine an ionic balance between cations and anions. Nutrients were measured in order to detect elevated concentrations in the streams. Metals were measured to determine unusual concentrations of metals that might be related to weathering of manufactured metallic objects. Eight of the samples were scanned to detect the possible presence of man-made organic compounds.

Discharge and results of inorganic analyses are presented in table 3. Discharge ranged from less than 0.01 to 1.8 ft^3/s . Conductivity ranged from 22 to 591 $\mu\text{S}/\text{cm}$ and dissolved-solids residue from 32 to 324 mg/L . For freshwater, conductivity is often used as an indicator of the dissolved-solids concentration; the relation between the two for this study area is shown on figure 9. Alkalinity ranged from 1 to 201 mg/L as CaCO_3 . Dissolved chloride ranged from 0.8 to 49 mg/L ; and dissolved manganese, from 1 to 8,600 $\mu\text{g}/\text{L}$.

Of the constituents and properties analyzed, only pH and four metals at 6 out of 26 sites had values that were not within the recommended limits for drinking water set by the Tennessee Department of Environment and Conservation (1994). The State has set secondary maximum contaminant levels for pH, iron (Fe), manganese (Mn), and aluminum (Al), and it

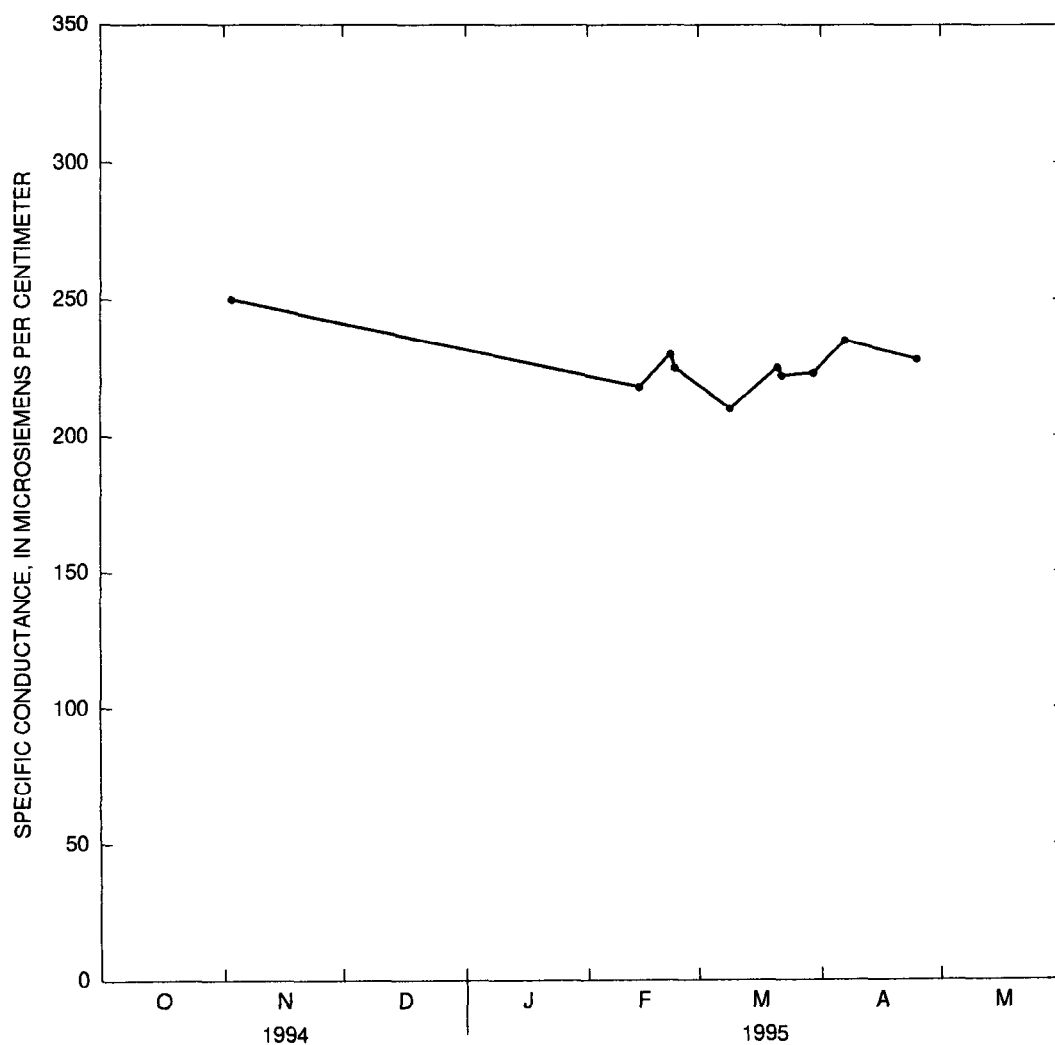


Figure 5. Conductivity of water at site 3005, near the mouth of Anderton Branch near Raus, Bedford County, Tennessee.

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee.

[MMDDYY, month, day, year; uS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L milligrams per liter; ft³/s, cubic foot per second; NTU, nephylene turbidity units; --, no data; Chatt sh, Chattanooga Shale; trib, tributary; rt, right; Fk, Fork; spr, spring; confl, confluence; <, less than]

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity as CaCO ₃ (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Shipman Creek												
0005	Shipman below Renegar	21795	132	10	--	--	--	--	10	--	--	--
Renegar Branch												
1005	At mouth by Shipman	21495	190	4.4	70	8	7.7	--	0.4	0.1	--	--
1005		21795	190	9	78	6	--	--	1.5	0.1	--	--
1010	Stream opposite house	21795	182	95	--	--	--	--	2	--	--	--
1015	Upstream by barn	21795	177	9.5	--	--	--	--	1.3	--	--	--
1020	Spring another 780' up	21795	273	14.5	--	--	6.5	--	0.04	--	--	--
1025	Rt bank small spring	21795	232	13.5	--	--	--	--	0.01	--	--	--
1030	Stream near Sycamore tree	21795	165	9.5	--	--	--	--	2	--	--	--
1035	W. Fk of Renegar	21795	173	10.5	70	2	6.7	--	0.7	--	--	--
1040	E Fk of Renegar	21795	154	8.5	64	11	6.2	--	1.5	<0.1	--	--
1045	E Fk, below pond	21795	150	9	--	--	6.6	--	1	--	--	--
1050	Midway up E Fk Renegar	21795	137	9	--	--	--	--	1.2	--	--	--
1055	E Trib of E Fk Renegar	21795	116	9	44	6	6.2	--	0.7	0.1	--	--
1060	Rt bank spring up #1055	21795	118	9.5	--	--	6.2	--	0.05	--	--	--
1065	E trib of E Fk above spr	21795	81	8.5	--	--	6.2	--	0.2	--	--	--
1070	Dry channel										--	--
1075	W trib of E Fk Renegar	21795	92	10	--	--	6.3	--	0.6	--	--	--
1080	Spring on W trib of E Fk	21795	--	--	--	--	--	--	0.07	--	--	--
1085	Stream sample near spring	21795	<50	10.5	--	--	6	--	--	--	--	--
1090	E trib of W trib of E Fk	21795	--	--	--	--	--	--	0.1	--	--	--
1095	E Fk, top of Chatt	21795	--	--	--	--	--	--	0.1	--	--	--
1100	Headwaters of E Fk	21795	--	--	--	--	--	--	0.02	--	--	--
1105	Headwaters of E Fk	21795	--	--	--	--	--	--	0.02	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Anthony Branch												
2005	At Route 276	21495	253	7.5	120	12	8.1	--	--	0.2	--	--
2005		22395	273	13.8	126	6	7	--	1.5	0.4	--	--
2010	At log cabin	22395	230	13.8	122	8	6.9	--	1.3	0.4	--	--
2015	Rt bank spr trib (marsh)	22395	364	12.6	182	8	7	--	0.08	0.6	--	--
2020	Near yellow barn	22395	231	13	118	12	6.7	--	1	0.2	--	--
2025	Left bank spr trib	22395	332	11.9	168	13	6.8	--	0.02	0.4	--	--
2030	Resurg in cow pasture	22395	224	10.6	110	6	6.9	--	0.8	0.2	--	--
2035	disappearing lf bank spr	22395	446	12	--	--	--	--	0.01	--	--	--
2040	Dry creek bed	22395	--	--	--	--	--	--	--	--	--	--
2045	At swallet	22395	140	11.8	60	7	7	--	0.1	<0.1	--	--
2050	Culvert near house	22295	137	9.5	62	10	7	--	0.6	<0.1	--	--
2050		22395	137	9.5	64	8	6.8	--	0.6	<0.1	--	--
2055	Iron spr, rt bank by dam	22395	183	--	80	9	5.8	--	0.02	0.4	--	--
2060	Pond resurgence	22395	128	9.4	60	7	7	--	0.8	<0.1	--	--
2065	N Fk above shallow Pond	22295	126	10.3	54	12	6.5	--	0.6	<0.1	--	--
2070	N Fk, rt bank spr	22295	229	10	98	13	6.7	--	0.02	0.1	--	--
2080	S trib of N Fk top Chatt	22295	40	10	2	1	6	--	0.04	<0.1	--	--
2090	N trib of N Fk, base Chat	22295	71	9	30	9	6.5	--	0.04	<0.1	--	--
2100	N trib of N Fk, top Chatt	22295	<50	10	--	--	6	--	--	--	--	--
2105	S Fk above Burn's Pond	22295	126	11	54	10	6.8	--	0.5	<0.1	--	--
2110	N trib of S Fk	22295	73	9.5	26	10	6.7	--	0.2	<0.1	--	--
2115	S trib of S Fk	22295	76	9	28	11	6.5	--	0.07	<0.1	--	--
2120	Disappearing (dry) stream	22295	--	--	--	--	--	--	--	--	--	--
2125	Spr up S trib of S Fk	22295	34	9	14	3	6	--	0.03	0.1	--	--
2130	S trib of S Fk base Chatt	22295	34	11	--	--	6	--	0.07	--	--	--
2135	S trib of S Fk top Chatt	22295	dry	--	--	--	--	--	--	--	--	--
2145	S trib, S Fk dry ravine	22295	dry	--	--	--	--	--	--	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees Celsius)	Alkalinity as CaCO3 (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft3/s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Anderton Branch												
3005	At Route 276	110294	254	--	118	18	--	6.5	--	0.5	--	--
3005		21495	218	7.5	86	14	--	--	1.3	0.4	--	--
3005		22295	230	14	100	14	7	--	1.7	0.3	--	--
3005		22395	225	13.3	102	17	6.8	--	2.1	0.4	--	--
3005		30995	210	10.3	--	--	6.9	8.5	6	--	40	--
3005		32195	223	15.3	89	5	7.2	8.6	1.4	1	--	0.08
3005		32295	222	15.4	102	5	7.9	--	1.78	0.6	--	0.01
3005		33095	225	16.2	102	3	7.7	--	--	0.9	--	0.06
3005		40795	235	21.7	105	8	8.1	8.5	1.4	0.6	6	0.13
3005		42595	228	14.7	--	--	--	--	2	--	--	--
3010	Below blue house	110294	224	15	108	7	--	3.1	1	0.3	--	--
3015	Pool by barnyard	110294	224	23	--	--	--	--	--	--	--	--
3020	Resurgence, 100'below...	110294	211	15	97	20	--	7.8	1.5	0.3	--	--
3025	Rt bank spring at 3020	110294	229	14	109	12	--	--	--	--	--	--
3030	Stream resurg (Reconn)	30995	227	12.4	86	10	6.9	7.6	--	0.7	16	--
3030	Stream resurg (seepage)	32295	215	12.8	85	6	7.1	--	0.84	--	--	--
3035	Harrison Saltpeter Cave	32295	295	15.3	138	4.6	7.05	--	0.28	1	--	<0.01
3035	Reconn - cave samples	32295	--	--	138	12	--	--	--	0.5	--	0.01
3040	Just before swallet	110294	131	16	61	10	--	7.5	--	0.2	--	--
3045	Pond Trib at culvert	110294	422	15	183	60	--	8	0.09	<0.1	--	--
3045		21495	354	7.4	114	40	7.5	7.5	0.05	0.1	--	--
3045	Pond trib (seepage)	32295	390	14.1	132	25	7.48	--	0.08	--	--	--
3045		32295	358	15.5	128	30	7.7	7.7	0.07	0.1	--	0.5
3050	Pond Trib, 500'upstream	32295	360	12.8	--	33	7	5.3	0.07	--	--	--
3055	Resurgence below dam	32295	353	13	--	30	7.1	8.3	--	--	--	--
3060	N. edge of pond	32295	322	16.6	--	--	8.2	12.8	0.01	--	--	--
3065	E. inlet weeps to pond	32295	153	16.1	--	--	--	--	0.00	--	--	--
3070	Center of Pond	32295	323	16.6	--	--	8.2	13.7	--	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Anderton Branch												
3075	W. inlet to Pond (Sons')	32295	338	14.4	--	--	7.5	10.8	0.05	--	--	--
3076	Quarter way up Sons' Trib	32295	357	11.9	--	--	6.9	7.1	0.02	--	--	--
3080	Sons' Trib resurgence	32295	329	11.2	--	29	6.7	8.8	--	--	--	--
3085	Sons' Trib, 100' below spr	32295	561	19	--	--	7.8	6.3	--	--	--	--
3090	Sons' spring (pool)	32295	617	16.4	200	45	6.1	3.7	0.02	1.1	--	5.7
3095	E. Trib inlet to Pond	32295	336	15.4	--	32	6.3	6.4	0.01	--	--	--
3100	Anderton above pond trib	21495	105	6.1	42	10	7.6	--	--	0.3	--	--
3100		32295	103	14.9	34	7	8.1	11.7	0.55	--	--	--
3100	(" samples from NSD)	32295	113	13.7	42	3	8	--	0.4	0.02	--	--
3105	Culvert by back entrance	110294	254	14	110	12	--	--	0.01	--	--	--
3110	At Brinkley Rd	110294	85	13	38	7	7.4	8.6	0.4	0.3	--	--
3110		32295	82	17	34	7	7.6	10.1	0.13	0.2	--	0.06
3115	Left bank seep	110294	148	--	63	5	--	--	--	--	--	--
3116	And. above left bank seep	110294	90	13	--	--	--	--	--	--	--	--
3120	Rt bank spring	32295	85	12.2	--	2	7.5	9	0.00	--	--	--
3125	Rt bank tributary	32295	49	13.8	--	2	7.5	7.7	--	--	--	--
3130	And. above Rt bank trib	32295	57	14.2	--	7	7.1	10.1	--	--	--	--
3135	And. below Yellowboy 2	32395	51	15.2	--	8	6.8	9.3	--	--	--	--
3140	Yellowboy 2 from landfill	32395	98	21.2	--	12	7.4	6.6	0.01	--	--	--
3145	Above Yellowboy 2	32395	50	15.1	--	--	6.9	9.2	0.08	--	--	--
3150	Rt bank trib (equiv YB2)	32395										
3155	Below W. & E. forks	32395	47	16.4	--	8	7.1	10.1	0.08	--	--	--
3160	W Fk draining landfill	32395	127	16.3	--	--	7.2	7.9	--	--	--	--
3165	Confl. Yellowboy1 & W F	32395	131	15.4	--	10	7.1	7.6	0.04	--	--	--
3170	Yellowboy1 from landfill	32395	496	16.3	--	43	6.8	6.45	--	--	--	--
3173	Kemp's seep at landfill	42595	591	18.5	65	49	5.9	--	<.01	--	--	235
3175	W Fk above Yellowboy1	32395	38	15.6	--	9	6.2	7.3	--	--	--	--
3180	Kemp's spring (top W Fk)	32395	27	15.5	12	<1	5.2	3.9	0.01	0.6	--	<0.01

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity as CaCO3 (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Anderton Branch												
3185	E Fk above W Fk confl.	32395	32	16.2	--	8	6.9	9.9	0.04	--	--	--
3190	Small cave on E. Fk.	32395	145	14.1	--	3	7	8.1	--	--	--	--
3195	Weeps and springs	32395	17	17.3	--	--	6.7	7.8	--	--	--	--
3200	E Fk, base Chatt Sh	32395										
3105	E Fk, top of Chatt Sh	32395	30	16.6	--	--	6.1	9.4	0.5	--	--	--
3210	Pool near top of E Fk	32395	43	15.2	8	3	5.7	10.1	0.08	0.6	--	0.08
3215	Cattle pond above E Fk	32395	37	20	--	--	6.1	9	--	--	--	--
3220	Springs at top of E Fk	32395	46	15.4	--	--	5.6	11.1	0.03	--	--	--
Powell Branch												
4005	At Bennett, Route 276	110395	348	14.3	--	--	--	--	0.1	--	--	--
4005		30995	275	13	124	8	7.3	8.2	3	0.8	--	0.07
4005		32295	311	15.7	153	3	7.8	--	0.53	0.7	--	0.03
4010	At lower road culvert	110395	350	14.6	--	--	--	--	0.1	--	--	--
4015	At upper road culvert	110395	348	15.3	--	--	--	--	0.1	--	--	--
4025	Culvert from S. spring	32295	316	15.4	143	9	7.2	--	0.1	1	--	0.03
4030	Above confluence w/ 402	110395	413	15.3	--	--	--	--	0.03	--	--	--
4030		33095	403	17.3	191	18	7.3	9.1	0.02	1.3	--	0.1
4035	Pool below cemetery entr	110395	480	16.3	--	--	--	--	--	--	--	--
4035		21495	440	11.3	210	20	7.3	--	--	0.8	--	--
4035		30995	327	13.8	156	10	6.7	6.8	0.1	0.8	--	0.32
4040	Seep at cemetery	110395	483	17.3	--	--	--	--	--	--	--	--
4045	Cemetery spring	32295	410	14.2	196	12	6.7	--	<.01	--	--	--
4050	Entr of S. spring	110395	352	14.9	--	--	--	--	--	--	--	--
4050		21495	331	11.7	150	8	7.8	--	--	0.7	--	--
4050		30995	306	13.2	--	--	7	7.8	1	--	--	--
4050		32295	316	15.4	143	9	7.2	--	0.1	--	--	--
4065	S. Spring orafice	33095	351	14	151	8	6.8	7.1	0.15	2	--	0.11
4070	Small "dry" cave opening	33095	dry	--	--	--	--	--	--	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Bennett Branch												
5005	Above Powell	21495	219	8	100	7	8.1	--	0.8	0.2	--	--
5005	(NSD seepage)	32195	219	14.8	103	3.4	7.7	--	0.9	0.3	--	--
5010	Kings spr, Route 130	32195	228	13.2	--	--	--	--	0.2	--	--	--
5015	Above Kings spr	32195	197	16.2	--	--	--	--	0.8	--	--	--
County Line Branch												
6005	At Route 130	3995	142	11.7	58	6	6.9	8.5	0.6	1.1	--	0.2
6005		32195	209	15.6	97	8	--	--	0.04	1	--	0.02
6005	(return trip same day)	32195	212	17.3	--	--	--	--	0.03	--	--	--
6005	(NSD seepage)	32295	219	15.2	101	3	7.6	--	0.03	--	--	--
6010	Spring box near mouth	32195	--	--	--	--	--	--	--	--	--	--
6015	Spring house - left bank	32195	224	13	105	10	--	--	0.02	1	--	--
6015	(return trip same day)	32195	224	12.9	--	--	--	--	0.02	--	--	--
6020	Opposite 6015	32195	223	15.4	100	4	--	--	0.02	0.9	--	--
6020	(return trip same day)	32195	224	14.2	--	--	--	--	0.02	--	--	--
6025	830' up	32195	dry	--	--	--	--	--	--	--	--	--
6030	1200' up	32195	183	14.9	79	9	--	--	0.01	0.8	--	0.06
6035	2400' up	32195	dry	--	--	--	--	--	--	--	--	--
6040	2610' up	32195	263	16.2	--	--	--	--	0.01	--	--	--
6045	2950' up	32195	61	18.4	17	3	--	--	0.02	0.6	--	0.01
6050	3280' up, head of flow	32195	35	12.6	15	2	--	--	0.02	1.8	--	0.05
6055	N Fk, no Chatt sh	32195	dry	--	--	--	--	--	--	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Daniel Hollow Branch												
7005	At Thompson Cr /resurg	21495	264	7.4	116	6	7.8	--	0.01	0.1	--	--
7005		32195	246	14	122	2	7.3	--	0.04	--	--	--
7010	10' above swallet	21495	251	9.4	110	6	8.4	--	0.03	0.2	3	0.03
7010		32195	172	15	78	2.7	7.6	--	0.03	--	--	--
7010		40595	260	14.5	120	7	8	7.5	0.13	0.1	--	--
7015	Pool 1360' above mouth	40595	284	13.9	112	9	7.6	8.8	0.03	0.6	3	0.03
7020	Midway up	40595	240	15.5	108	13	8.2	8.3	0.08	0.1	5	0.06
7025	100' above mailbox	40595	223	15.8	101	11	8.4	8.2	0.1	0.1	5	0.05
7030	Opposite Daniel barn	40595	200	14.6	95	7	8.6	7.8	0.1	0.4	5	0.06
7035	170' below top spring	40595	188	14.4	80	6	7.1	8.6	0.05	3	19	0.47
7040	Head spr & beagle pen	40595	186	12	--	--	6.6	7.9	0.01	--	--	--
Prince Branch												
8005	At Route 276	30995	108	10.8	40	3	6.8	8.8	5.4	0.3	15	--
8005		40795	158	19	69	4	7.8	6.5	2	0.5	6	--
8005		32295	114	14.6	63	2	8.1	--	1.1	--	--	--
8010	At top of cow pasture	40795	151	18.1	69	5	8.1	9.6	2.2	0.1	2	--
8015	Halfway up to N & S Fk	40795	144	17.6	70	5	8	9.4	1.2	0.2	4	--
8020	Left bank spr trib	30995	230	14.5	103	5	7.4	10	0.01	0.4	1	--
8025	Below confl of N & S	30995	85	10.4	36	2	6.9	8.9	4.5	0.2	3	--
8025		32295	129	14.4	48	2	7.7	--	1.6	--	--	--
8025		40695	132	16.4	--	--	7.8	9.3	0.8	--	--	--
8025		40795	131	18.2	--	--	7.9	8.9	0.8	--	--	--
8030	Rt bank spring near barn	30995	149	13.4	74	2	6.6	7.6	0.2	<0.1	--	--
8030		40695	256	14	--	--	7.3	7.4	--	--	--	--
8035	S Fk above confl	30995	90	10	26	2	6.8	9.1	1.5	0.7	5	--
8035		40695	125	16.5	48	7	8	9.6	0.36	1.4	3	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity as CaCO3 (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft ³ /s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Prince Branch												
8035		40795	122	19.1	--	--	7.9	7.9	--	--	--	--
8045	S Fk, 1st left bank trib	40795	85	15.7	--	--	7.3	12.5	0.00	--	--	--
8050	S Fk above 8045	40795	81	18	29	8	7.6	9	0.25	1.6	4	--
8055	S Fk base of Chatt Sh	40795	62	18.5	18	6	8.2	9.6	0.17	1.6	2	--
8060	S Fk, 2nd left bank trib	40795	83	14.2	33	4	7	9.1	0.02	2	1	--
8065	S Fk above Chatt & trib	40795	49	17.5	10	8	7	9.7	0.15	2.6	1	--
8070	N Fk above confl	30995	66	10.1	24	3	7.1	9	3	<0.1	8	--
8070		40695	96	17	43	5	7.9	9.2	0.48	<0.1	3	--
8070		40795	96	17.9	--	--	7.9	9.3	--	--	--	--
8075	N Fk, 1st rt trib, 50' up	40695	148	14.5	68	5	7.9	9.6	0.01	<0.1	2	--
8080	N Fk, 2nd rt trib	40695	83	14.2	--	--	7.5	8.8	0.01	--	--	--
8085	N Fk at confl w/ trib	40695	63	15.4	--	--	7.6	9.8	0.35	--	--	--
8090	N Fk below confl 2 trib	40695	49	15.5	--	--	7.4	7.1	--	--	--	--
8095	N Fk, left bank conduit	40695	184	11.8	--	--	7.4	9.3	0.00	--	--	--
8100	S trib of N Fk	40695	60	15.2	31	5	7.3	9.4	0.15	<0.1	3	--
8105	N trib of N Fk	40695	45	15.7	--	--	7.1	8.2	0.33	--	--	--
8110	N Fk, n trib, rt bank spr	40695	50	14.7	24	6	7.1	8.6	0.01	<0.1	7	--
8115	N Fk, n trib, base Chatt	40695	32	16.6	15	5	6.4	9.7	0.25	<0.1	4	--
8120	N Fk, rt bank chert spr	40695	19	17	--	--	6.4	8.1	--	--	--	--
8125	N Fk above Chatt Sh	40695	32	13.8	--	--	6.2	10.2	0.25	--	1	--
8130	N Fk, rt bank chert trib	40695	28	12.6	10	5	5.4	9.7	0.18	0.1	1	--
8135	N Fk above confl 8130	40695	29	13.6	--	--	6	9	0.13	--	--	--
8140	N Fk, headwater springs	40695	21	12.9	1	4	5.2	6.9	0.12	<0.1	2	--
8145	Center line Daniel Rd	40695	--	--	--	--	--	--	--	--	--	--

Table 1. Reconnaissance measurements of physical properties, selected chemical constituents, and estimated discharge at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees celsius)	Alkalinity as CaCO3 (mg/L)	Chloride (mg/L)	pH	Dissolved oxygen (mg/L)	Flow (ft3/s)	Nitrate as nitrogen (mg/L)	Turbidity (NTU)	Iron total (mg/L)
Hurricane Creek												
9005	At Route 55 Lynchbrg Hw	21495	27	8.6	6	10	7.2	--	0.3	0.4	--	--
9005		30395	28	7.4	2	5	5.6	11.7	1.9	0.5	--	0.2
9010	Rt bank spr, partly crib	21495	27	13.8	--	--	--	-	0.01	0.1	--	--
9010		30395	27	15.7	1	3	5.5	7.4	0.06	0.1	--	0.02
9015	100' above spr 9010	30395	30	7.6	1	7	5.3	9.9	1.6	0.5	17	0.31
9020	Corner of cornfield	21495	39	5.3	--	--	--	--	--	--	--	--
9020		30395	36	6	1	8	5.6	11.1	--	1	13	2
9025	400' below s. outfall	30395	37	6	1	8	5.6	10.2	1.1	1.1	--	--
9030	150' below outfall	30395	37	5.8	3	8	5.5	9.1	1.7	1.1	33	--
9030	(return trip same day)	30395	34	6	--	--	5.5	9.3	1.7	--	29	--
9035	Outfall gray water	30395	101	7.3	17	20	6	8	--	2.4	21	--
9040	Trib behind Motlow Coll	30395	13	5.9	<1	2	5.2	7.3	0.05	<0.1	1.4	--
9045	Up trib behind Motlow	21495	14	4.2	<1	<1	4.7	0	0.02	<0.1	--	--
9045		30395	15	4.9	<1	2	5.1	8.7	0.04	<0.1	1.4	-
9050	Main (E) Fk, tannic	30395	18	4.8	<1	2	4.4	9.5	1	<0.1	--	--
9055	E Fk, 2000' abv outfall	30395	22	5.5	<1	2	4.3	8.5	0.8	<0.1	15	0.8
9060	N trib of E Fk, smaller	30395	25	5.8	--	--	3.9	8.2	0.3	--	21	--
9065	S trib of E Fk, lrgtr trib	30395	21.2	5.5	--	--	4.4	8.7	0.5	--	20	--

Table 2. Reconnaissance measurements of benthic macroinvertebrate diversity and abundance at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee.

[trib, tributary; Fk, Fork; spr, spring; Chatt, Chattanooga shale; E, East; N, North; S, South; resurg, resurgence; --, no data]

Map number	Site description	Month, day, year	Snails	Mayfly	Caddisfly	Stonefly	Water-penny	Aquatic worm	Other macroinvertebrates	Vegetation
Renegar Branch										
0005	Shipman below Renegar	21795	>10	--	--	--	--	--	--	watercress on banks
1005	Renegar at mouth by Shpmn	21495	41	3	13	--	--	--	--	--
1005	Opposite house	21795	>10	--	--	--	--	--	--	--
1010	Stream opposite garage	21795	--	--	--	--	--	--	--	bl. gr. algae mats
1015	Upstream by barn	21795	>50	--	--	--	--	--	--	--
1045	E Fk, rt abutment of pond	21795	--	--	--	--	--	--	--	watercress on bank
Anthony Branch										
2005	At Route 276	22395	10	9	3	2	1	0	14 midges, many minnows	--
2010	At log cabin	22395	16	2	8	1	0	0	many minnows	covered periphyton
2015	Rt bank spr trib (marsh)	22395	17	21	15	5	0	0	--	cattail, black willow
2020	Near yellow barn	22395	>50	4	23	0	0	0	♂ sewage fly (Limnophorus)	green periphyton
2030	Resurg in cow pasture	22395	4	--	--	--	--	--	sunfish of various size	--
2050	Culvert near house	22395	0	6	15	0	0	15	midges, rattail maggot	gr filament algae
2055	Iron spr, rt bank by dam	22395	0	0	0	0	0	0	--	iron reducing bacteria
2060	Pond resurgence	22395	18	0	2	0	0	0	isopod, salamander, helgrammite	--
2065	N Fk above shallow pond	22295	8	0	5	0	11	0	frogs & tadpoles	--
2070	Spring N Fk by pump house	22295	2	1	7	1	1	1	--	gr filamentous algae
2080	S trib of N Fk, top Chatt	22295	3	3	8	0	0	1	--	--
2090	N trib of N Fk base Chatt	22295	3	0	5	11	0	0	frog	--
2105	S Fk above shallow pond	22295	3	0	14	0	0	0	white eggs	watercress on banks
2110	N trib of S Fk	22295	2	0	6	0	1	1	isopod & salamander	--
2115	S trib of S Fk	22295	0	8	0	1	1	0	crayfish	--
2125	Spr up S trib of S Fk	22295	0	0	8	0	1	0	helgrammite	--
2130	S trib of S Fk base Chatt	22295	3	3	5	0	0	0	helgrammite	--

Table 2. Reconnaissance measurements of benthic macroinvertebrate diversity and abundance at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Month, day, year	Snails	Mayfly	Caddisfly	Stonefly	Water-penny	Aquatic worm	Other macroinvertebrates	Vegetation
Anderton Branch										
3005	At Route 276	21495	4	1	6	1	2	0	--	--
3005		22295	1	1	0	0	0	0	midge, clam midges	--
3005		22395	4	5	0	2	9	0	--	--
3045	Pond trib at Anderton	32295	10	2	5	--	--	--	--	--
3050	Pond Trib, 500' upstream	32295	5	1	3	--	--	--	--	--
3060	N. edge of pond	32295	5	--	--	--	--	--	--	--
3070	Center of Pond	32295	5	--	--	--	--	--	100 midges	phytoplankton
3075	W. inlet to Pond	32295	0	--	--	--	--	--	--	filamentous algae
3076	Quarter way up Son's Trib	32295	0	--	--	--	--	--	--	--
3085	Sons' Trib, 100' below spr	32295	--	--	--	--	--	--	(inadequate hydrology)	--
3090	Sons' spring (pool)	32295	0	0	0	0	0	0	--	--
3100	Anderton above pond trib	32295	>10	22	>5	--	--	--	--	--
3110	At Brinkley Rd	110294	>10	1	2	10	10	--	--	--
3173	Kemp's seep at landfill	32395	0	0	0	0	0	0	--	--
3175	W Fk abv Yellowboy l	32395	0	>10	>10	--	>10	--	--	--
3205	E Fk, top Chatt. Shale	32395	>10	>20	--	>25	--	0	salamanders, crayfish	--
3210	Pool near top of E Fk	32395	>10	>10	>20	>25	>10	0	salamanders, crayfish	--
Powell Branch										
4005	At Route 276	110395	>50	0	0	0	0	0	--	--
4005		30995	>50	11	18	0	4	0	--	--
4015	At upper road culvert	110395	--	--	--	--	--	--	--	algae
4030	Above confl w/ 4025	33095	>20	0	0	0	0	0	--	gr periphyton
4035	Pool below cemetery entrance	21495	--	--	--	--	--	--	--	watercress
4050	Spring culvert across road	110395	>20	10	--	--	--	--	--	--
4065	Spring pool	33095	--	--	--	--	--	--	--	watercress, peppermint

Table 2. Reconnaissance measurements of benthic macroinvertebrate diversity and abundance at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Month, day, year	Snails	Mayfly	Caddisfly	Stonefly	Water-penny	Aquatic worm	Other macroinvertebrates	Vegetation
Bennett Branch										
5005	Above Powell	21495	7	6	22	1	5	0	--	--
County Line Branch										
6005	At Route 130	3995	0	1	6	0	0	0	crayfish	--
6005		32195	0	0	0	0	0	0	(road construction)	algae, watercress
6015	Spring house - left bank	32195	0	4	0	0	0	0	--	--
6030	1200' up	32195	5	2	0	0	0	0	--	watercress
6035	2400' up, Olcy	32195	--	--	--	--	--	--	(frogs)	filamentous algae
6045	2950' up	32195	0	0	0	0	0	0	helgramite	filamentous algae watercress
6050	3280' up, head of flow	32195	0	0	0	0	0	5	waterstrider, frogs	algae
Daniel Hollow Branch										
7005	At Thompson Cr /resurg	21495	2	6	0	0	0	0	midge, flat worm	--
7010	10' above swallet	21495	0	0	6	0	0	0	midge	filamentous algae
7015	Pool 1360' above mouth	40595	--	--	--	--	--	--	2 darter species	--
7025	100' above mailbox	40595	--	--	--	--	--	--	--	watercress
7030	Opposite Daniel barn	40595	0	0	0	5	0	0	white eggs	--
Prince Branch										
8005	At Route 276	30995	36	15	22	0	0	0	red watermies	--
8015	Halfway up to N & S Fk	40795	70	0	10	2	2	0	numerous wht eggs	--
8020	Left bank spr trib	30995	70	0	30	0	0	0	--	abundant watercress
8025	Below confl of N & S	30995	41	0	5	3	0	0	--	--
8035	S Fk above confl	30995	55	23	11	0	3	0	--	--
8050	S Fk above 8045	40795	70	30	30	0	0	0	frogs & crayfish	--
8060	S Fk, 2nd left bank trib	40795	70	3	30	1	0	0	salamanders & wht eggs	--
8065	S Fk above shale & trib	40795	0	3	30	5	0	0	crayfish	--

Table 2. Reconnaissance measurements of benthic macroinvertebrate diversity and abundance at sites on nine streams in southeastern Bedford and northeastern Moore Counties, Tennessee - continued.

Map number	Site description	Month, day, year	Snails	Mayfly	Caddisfly	Stonefly	Water-penny	Aquatic worm	Other macroinvertebrates	Vegetation
Prince Branch										
8070	N Fk above confl	30995	26	6	6	0	0	1	--	--
8090	N Fk below confl 2 tribs	40695	21	3	0	2	0	0	salamanders & crayfish	diatoms
8115	N Fk, N trib base Chatt	40695	8	4	7	0	0	0	blk flies & moth larvae	--
8125	N Fk above Chatt Sh	40695	11	0	2	0	2	0	damselfly, aq moth larva helgrammite, crayfish, water strider, spider, salamander limpets, backswimmer helgrammite	--
8135	N Fk above confl 8130	40695	0	2	15	0	0	0		Brachiospermum algae
8140	N Fk, headwater springs	40695	0	0	0	2	0	0	midge, back swimmer, water strider	filamentous algae, decay lvs
Hurricane Creek										
9005	At Route 55, Lynchburg Hwy	21495	0	0	0	0	0	8	1 rattail maggot, 1 isopod	filamentous algae
9005		30395	0	0	0	0	0	14	--	filamentous alfae
9010	Rt bank spr, partly crib	21495	0	0	0	0	0	0	--	gr phytoplankton
9010		30395	0	0	0	0	0	0	--	gr phytoplankton
9015	100' above spr 9010	30395	5	0	0	0	0	2	--	filamentous algae
9020	Corner of cornfield	21495	--	--	--	--	--	--	--	filamentous algae
9020		30395	--	--	--	--	--	--	--	filamentous algae
9025	400' below s. outfall	30395	2	0	0	0	0	11	--	gr single cell periphyton
9040	Trib behind Motlow Coll	30395	0	0	0	0	0	0	--	sphagnum moss
9045	Up trib behind Motlow	21495	--	--	--	--	--	--	--	sphagnum moss
9045		30395	0	0	0	0	0	0	--	sphagnum moss
9050	Main (E) Fk, tannic	30395	0	0	0	0	0	7	1 isopod	Chlorococcum algae
9055	E Fk, 2000' abv sewer	30395	0	0	0	0	0	28	--	--

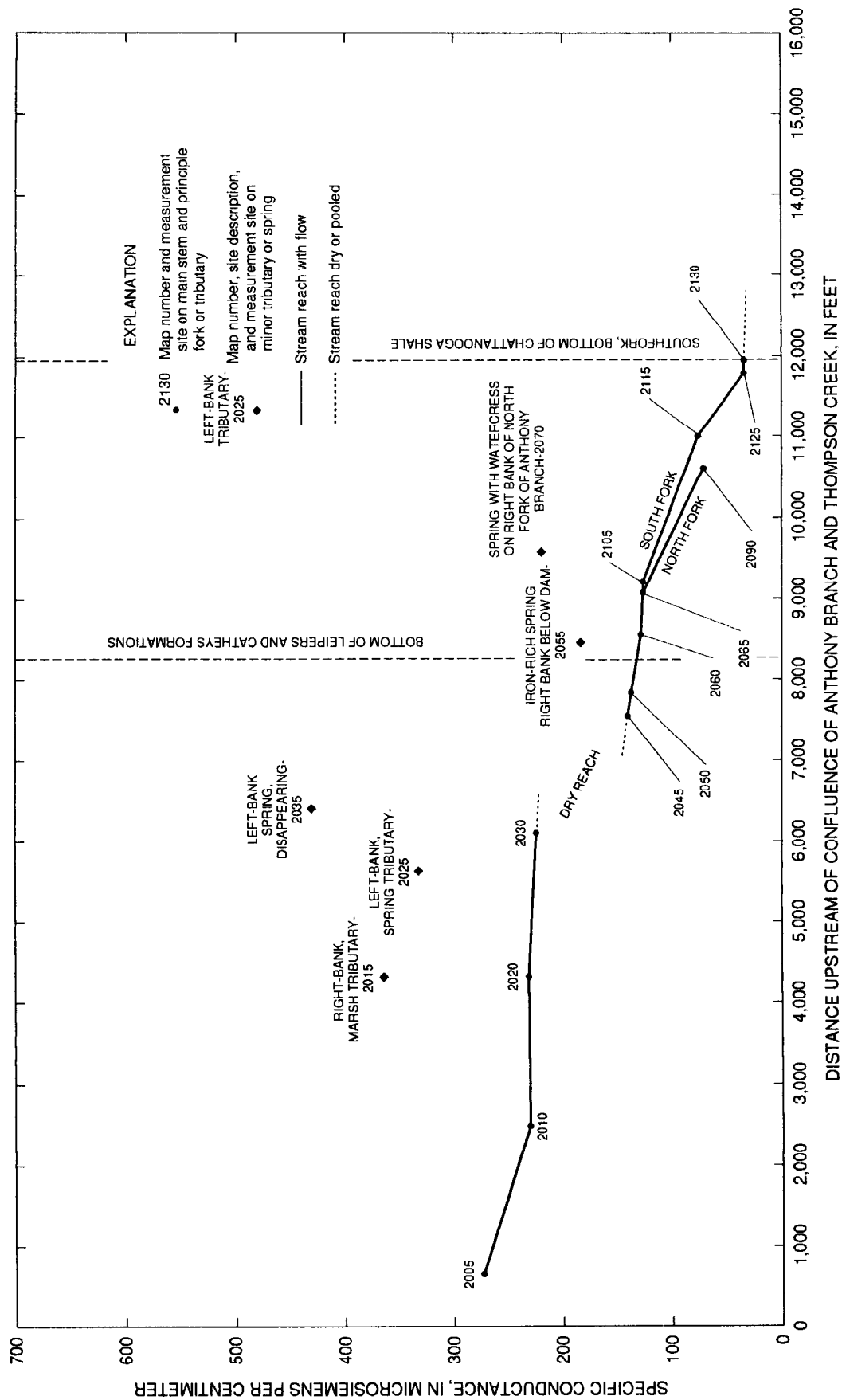


Figure 6. Conductivity profile for Anthony Branch near Raus, Bedford County, Tennessee, February 22 and 23, 1995.

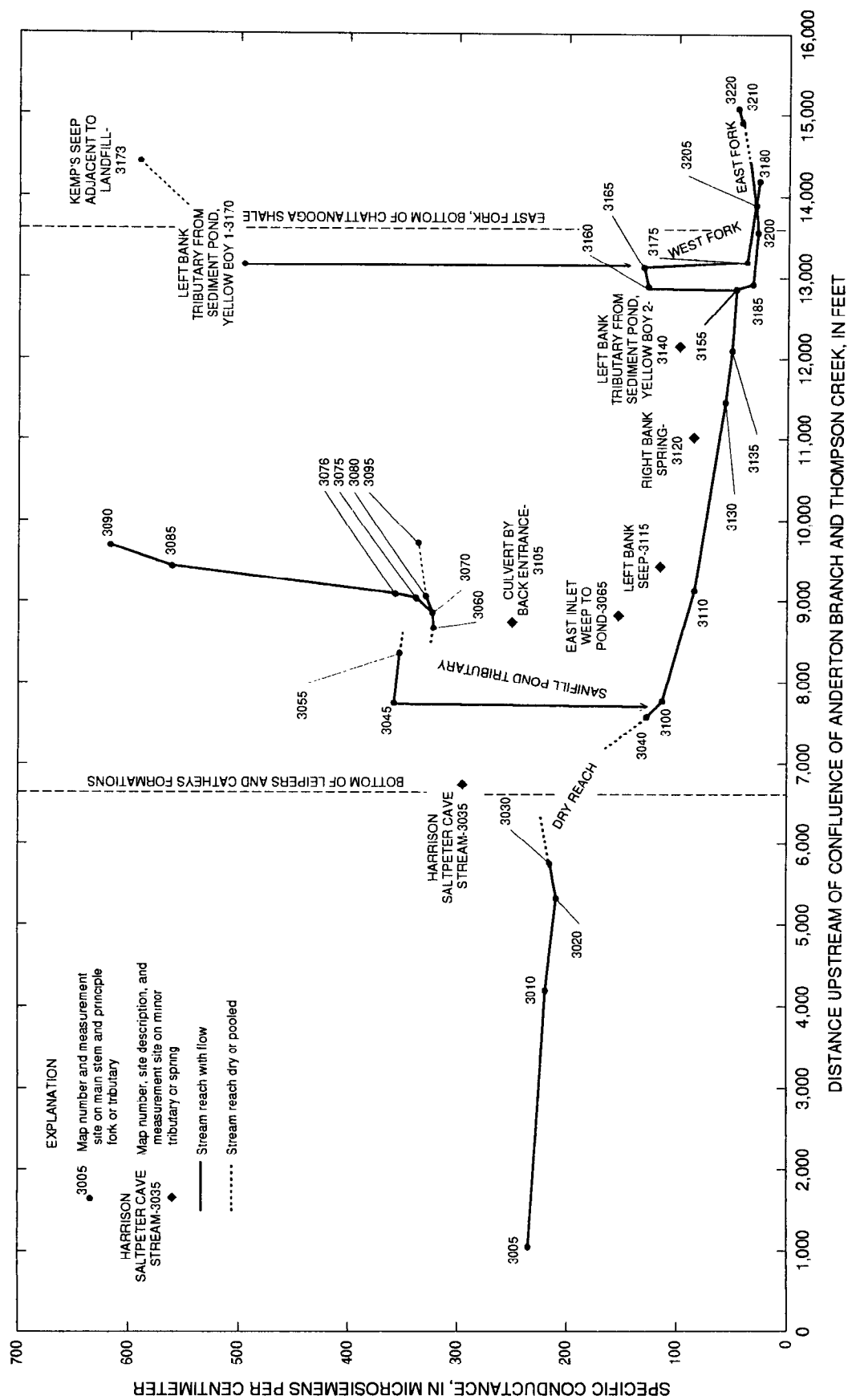


Figure 7. Conductivity profile for Anderton Branch near Raus, Bedford County, Tennessee, March 22 and 23 and April 25, 1995.

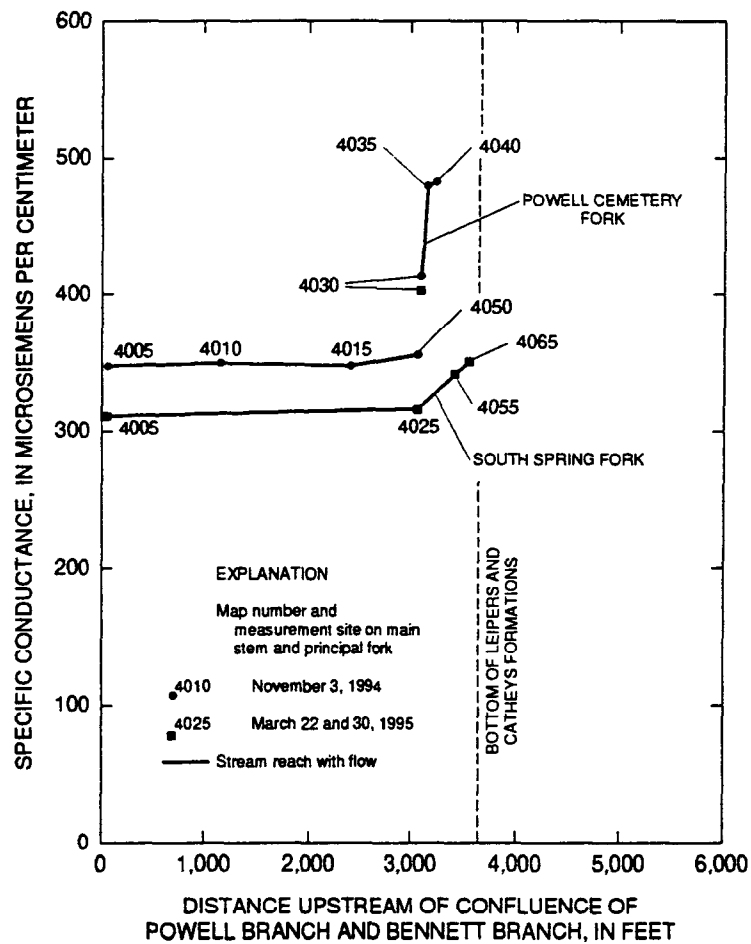


Figure 8. Conductivity profile for Powell Branch at Raus, Bedford County, Tennessee, November 3, 1994, and March 22 and 30, 1995.

Table 3. Laboratory measurements of water quality for samples collected during the seepage investigation in Bedford and Moore Counties, Tennessee, March 22, 1995 and April 25, 1995.

[MMDDYY, month, day, year; uS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ug/L, micrograms per liter; <, less than; ft³/s, cubic feet per second]

Map number	Site description	Date (MMDDYY)	Specific conductance (uS/cm)	Temperature (degrees Celsius)	Field pH	Lab pH	Flow (ft ³ /s)	Dissolved			Dissolved		
								nitrite as nitrogen (mg/L)	nitrate (mg/L)	nitrite + nitrate (mg/L)	phosphorous (mg/L)	phosphorous (mg/L)	phosphorous (mg/L)
1010	Renegar by house	32295	179	16.5	8.1	8.2	0.44	<.01	0.13	0.13	0.02	0.02	0.02
1035	Renegar at W Fork	32295	158	14	7.8	8.1	0.16	<.01	0.24	0.24	0.01	0.01	0.01
1045	Renegar at E Fk	32295	142	15	8.4	8	0.13	<.01	0.08	0.08	0.02	0.02	0.02
2005	Anthony, Route 276	32295	300	13.5	7.9	8.2	0.92	<.01	0.38	0.38	0.06	0.06	0.06
2026	Anthony below resurg	32295	231	14.5	7.2	7.9	0.7	<.01	0.27	0.27	0.07	0.07	0.07
2045	Anthony at swallet	32295	142	17	7.7	8	0.39	0.01	0.02	0.02	0.01	0.01	0.01
2060	Anthony below pond	32295	132	15	8.9	8.1	0.35	<.01	<.02	<.02	0.01	0.01	0.01
3005	Anderton, Route 276	32295	222	15.5	7.8	7.9	1.8	<.01	0.58	0.58	0.04	0.04	0.04
3030	Anderton at resurgence	32295	215	13	7.1	7.8	0.84	<.01	0.51	0.51	0.02	0.02	0.02
3035	Harrison SP Cave	32295	295	15.5	7	7.7	0.28	<.01	1	1	0.03	0.03	0.03
3045	Pond trib at culvert	32295	390	14	7.5	8.2	0.08	0.01	0.07	0.07	0.01	0.01	0.01
3090	Sons' spring pool	42595	532	16	5.9	6.7	0.01	<.01	3.3	3.3	0.01	0.01	0.01
3100	Anderton above pond trib	32295	113	13.5	8	8	0.87	0.03	0.36	0.36	0.01	0.01	0.01
3173	Kemp's seep	42595	591	18.5	5.9	5.9	<.01	<.01	0.07	0.07	0.03	0.03	0.03
4005	Powell at Route 276	32295	311	15.5	7.8	8.3	0.53	0.01	0.68	0.68	0.07	0.07	0.07
4025	Powell spring culvert	32295	328	15	7.2	8.3	0.18	<.01	0.05	0.05	0.05	0.05	0.05
4035	Powell above culvert	32295	403	15	6.6	7.6	0.01	<.01	0.1	0.1	0.1	0.1	0.1
5005	Bennett at Raus TN	32295	219	15	7.7	8.2	0.94	<.01	0.04	0.04	0.04	0.04	0.04
6005	County Line Branch	32295	219	15	7.6	8.3	0.03	<.01	0.05	0.05	0.05	0.05	0.05
7010	Daniel above swallet	32295	246	14	7.3	8.3	0.04	<.01	0.02	0.02	0.02	0.02	0.02
7035	Daniel near headwater	32295	172	15	7.6	7.6	0.03	<.01	0.08	0.08	0.08	0.08	0.08
8005	Prince Route 276	32295	129	14.5	7.6	8	1.6	<.01	0.02	0.02	0.02	0.02	0.02
8025	Prince below N & S Fk	32295	114	14.5	8.1	8.1	1.1	<.01	<.01	<.01	<.01	<.01	<.01
9005	Hurricane Route 55	32295	32	12	6.7	6.2	0.71	0.01	0.01	0.01	0.01	0.01	0.01
9025	Hurricane below outfall	32295	35	12.5	6	5.9	0.69	0.01	0.02	0.02	0.02	0.02	0.02
9050	Hurricane above outfall	32295	22	13	5	4.8	0.42	0.01	0.01	0.01	0.01	0.01	0.01

Table 3. Laboratory measurements of water quality for samples collected during the seepage investigation in Bedford and Moore Counties, Tennessee, March 22, 1995 and April 25, 1995 - continued .

[MMDDYY, month, day, year; uS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ug/L, micrograms per liter; <, less than; ft3/s, cubic feet per second]

Map number	Site description	Date (MMDDYY)	Dissolved calcium (mg/L)	Dissolved magnesium (mg/L)	Dissolved sodium (mg/L)	Dissolved potassium (mg/L)	Dissolved chloride (mg/L)	Dissolved sulfate (mg/L)	Dissolved cadmium (ug/L)	Dissolved chromium (ug/L)
1010	Renegar by house	32295	31	2.8	1	0.6	1.2	7.1	<1	<5
1035	Renegar at W Fork	32295	27	2.5	1.1	0.4	1.4	7.4	<1	<5
1045	Renegar at E Fk	32295	24	2.4	0.8	0.4	0.8	6.7	<1	<5
2005	Anthony, Route 276	32295	49	4.2	1.1	0.7	1.7	7.4	<1	<5
2026	Anthony below resurg	32295	40	3.4	1	0.9	1.5	7.6	<1	<5
2045	Anthony at swallet	32295	24	2.1	0.8	0.5	1.1	6.1	<1	<5
2060	Anthony below pond	32295	23	1.9	0.8	0.5	1	6.2	<1	<5
3005	Anderton, Route 276	32295	39	3.2	2.6	1.6	4.9	6.3	<1	<5
3030	Anderton at resurgence	32295	32	3	3	1	5.5	6.4	<1	<5
3035	Harrison SP Cave	32295	52	4.7	2.3	0.8	4.6	8.5	<1	<5
3045	Pond trib at culvert	32295	56	3.3	13	2.4	25	9.8	<1	<5
3090	Sons' spring pool	42595	77	6.1	20	5.2	34	26	3.1	<5
3100	Anderton above pond trib	32295	16	1.8	1.6	0.8	2.9	4.2	<1	<5
3173	Kemp's seep	42595	12	3.2	34	1.7	49	1.6	2.5	<5
4005	Powell at Route 276	32295	57	4.4	1.4	0.9	3.1	4.8	<1	<5
4025	Powell spring culvert	32295	58	5.1	1.4	0.8	3.7	5.3	<1	<5
4035	Powell above culvert	32295	74	7.5	1.6	0.9	4.4	8.4	<1	<5
5005	Bennett at Raus TN	32295	38	2.8	1.9	0.7	3.4	5.5	<1	<5
6005	County Line Branch	32295	38	3	1.1	1.1	2.7	6.5	<1	<5
7010	Daniel above swallet	32295	45	3.5	1.2	0.6	2	6	<1	<5
7035	Daniel near headwater	32295	31	2.6	1.5	0.9	2.7	8	<1	<5
8005	Prince Route 276	32295	24	2.1	1	0.6	2	4.3	1	<5
8025	Prince below N & S Fk	32295	19	1.9	1	0.5	2.1	3.9	1	<5
9005	Hurricane Route 55	32295	3.6	0.8	1.7	0.7	3.3	2.8	1	<5
9025	Hurricane below outfall	32295	4.8	0.6	1.5	0.7	2.5	2.2	<1	<5
9050	Hurricane above outfall	32295	1.7	0.4	1.1	0.6	1.7	1.6	<1	<5

Table 3. Laboratory measurements of water quality for samples collected during the seepage investigation in Bedford and Moore Counties, Tennessee, March 22, 1995 and April 25, 1995 - continued.

[MMDDYY, month, day, year; uS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ug/L, micrograms per liter; <, less than; ft³/s, cubic feet per second]

Map number	Site description	Date (MMDDYY)	Dissolved				Solids, residue at 180 deg. C				Lab Alkalinity (mg/L)	Lab specific conductance (uS/cm)
			iron (ug/L)	lead (ug/L)	manganese (ug/L)	nickel (ug/L)	dissolved zinc (ug/L)	dissolved aluminum (ug/L)				
1010	Renegar by house	32295	9	<1	4	<10	<4	<20	106	84	180	
1035	Renegar at W Fork	32295	6	<1	4	<10	5	<20	94	71	161	
1045	Renegar at E Fk	32295	28	<1	16	<10	5	<20	86	63	143	
2005	Anthony, Route 276	32295	8	<1	11	<10	<4	<20	144	134	273	
2026	Anthony below resurg	32295	20	<1	22	<10	6	<20	132	108	230	
2045	Anthony at swallet	32295	36	<1	23	<10	6	<20	80	63	143	
2060	Anthony below pond	32295	18	<1	12	<10	<4	<20	74	60	138	
3005	Anderton, Route 276	32295	11	<1	19	<10	20	<20	122	102	231	
3030	Anderton at resurgence	32295	10	<1	2	<10	18	<20	108	85	200	
3035	Harrison SP Cave	32295	<3	<1	1	<10	7	<20	170	138	299	
3045	Pond trib at culvert	32295	7	<1	3	<10	46	<20	194	132	352	
3090	Sons' spring pool	42595	80	<1	2800	110	64	20	324	184	536	
3100	Anderton above pond trib	32295	17	<1	34	<10	7	<20	54	42	106	
3173	Kemp's seep	42595	98000	<1	8600	200	29	30	152	65	301	
4005	Powell at Route 276	32295	3	<1	7	<10	5	<20	178	153	306	
4025	Powell spring culvert	32295	22	<1	23	<10	10	<20	178	158	319	
4035	Powell above culvert	32295	3	<1	44	<10	18	<20	226	201	410	
5005	Bennett at Raus TN	32295	5	<1	6	<10	7	<20	120	103	220	
6005	County Line Branch	32295	9	3	8	<10	26	<20	116	101	217	
7010	Daniel above swallet	32295	5	<1	5	<10	7	<20	138	122	249	
7035	Daniel near headwater	32295	24	<1	26	<10	17	20	104	78	185	
8005	Prince Route 276	32295	12	<1	10	>10	5	<20	80	63	145	
8025	Prince below N & S Fk	32295	11	<1	2	<10	7	<20	64	48	117	
9005	Hurricane Route 55	32295	370	<1	16	<10	25	330	32	4.5	35	
9025	Hurricane below outfall	32295	860	<1	42	<10	23	560	50	4.8	35	
9050	Hurricane above outfall	32295	1200	<1	52	<10	26	710	60	1	24	

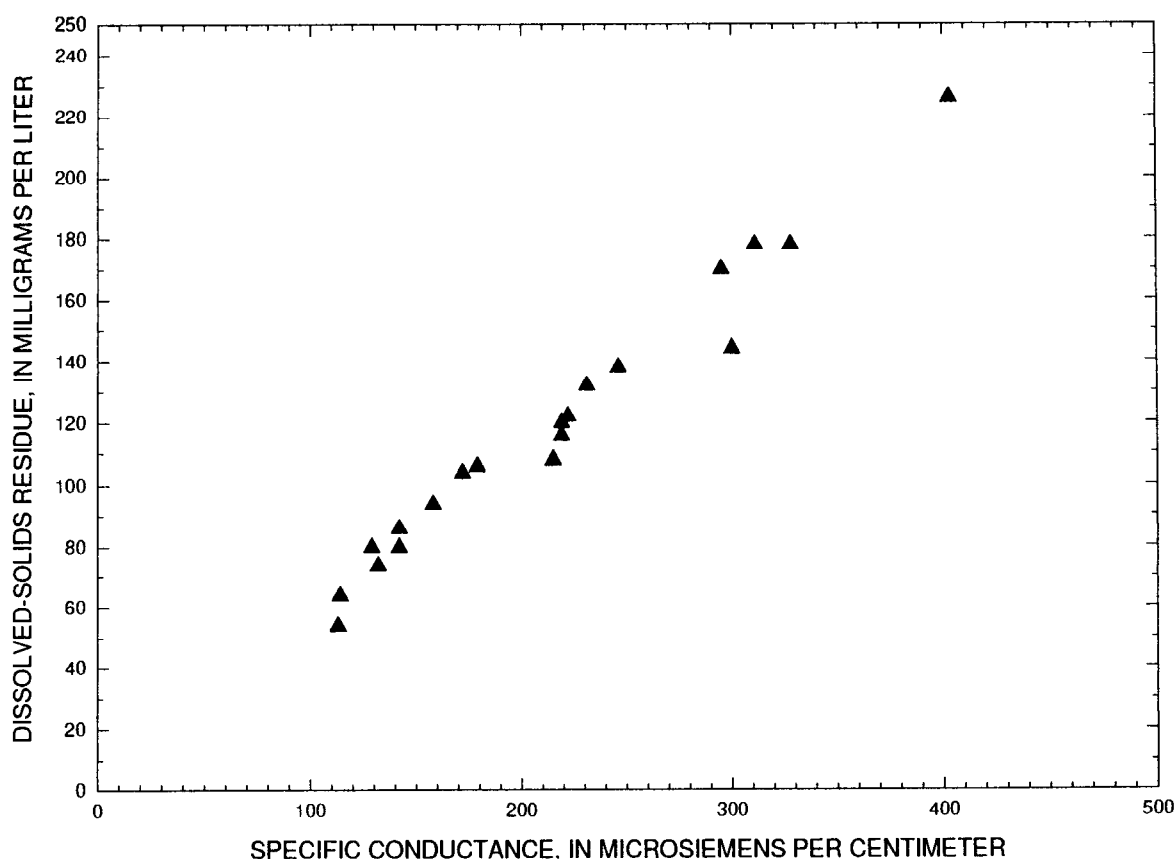


Figure 9. Relation between specific conductance and dissolved-solids residue in water from Bedford and Moore Counties, Tennessee.

has set primary maximum contaminant levels for nickel (Ni). For pH, values must lie outside of a range in values in order to exceed. Results are summarized as follows:

Property or constituent	Maximum contaminant level	Sites exceeding contaminant level				
		Anthony Branch 2060	Anderton Branch 3090	3173	Hurricane Creek	
					9005	9025 9050
pH	<6.5 or >8.5	x	x	x		x x
Fe	300 µg/L			x	x	x x
Mn	50 µg/L		x	x		x
Ni	100 µg/L		x	x		
Al	200 µg/L				x	x x

Several water types occur in the study area and are shown by the shape of the "diamond" (fig. 10). Different shapes indicate different water types. For example, the shape for Kemp's seep (3173) is markedly different from Renegar Branch (1045) or Hurricane Creek (9005). Conductivity (fig. 11) is lowest for sites on the Highland Rim (9005, 9025, and 9050) and

highest for two sites adjacent to the landfill (3090 and 3173). In general, laboratory values for chloride (fig. 12) are less than 5 mg/L except at sites with small discharge near the landfill (3045, 3090, and 3173). Dissolved manganese values (fig. 13) are highest for Sons' Spring and Kemp's seep adjacent to the landfill (3090 and 3173).

Organic compound scans were conducted using the gas chromatography/flame-ionization detection (GS/FID) method at eight of the seepage sites (K.K. Doan, U.S. Geological Survey, written commun., 1995). This analytical method provided a semi-quantitative means for determining the presence and estimated concentration of natural and synthetic organic compounds. Specific compounds, however, were not identified using this technique. Scan results from Renegar Branch (fig. 14) were typical of results for sites distant from the landfill. Scan results from Sons' Spring and Kemp's seep adjacent to the landfill (figs. 15 and 16) indicated the presence of about

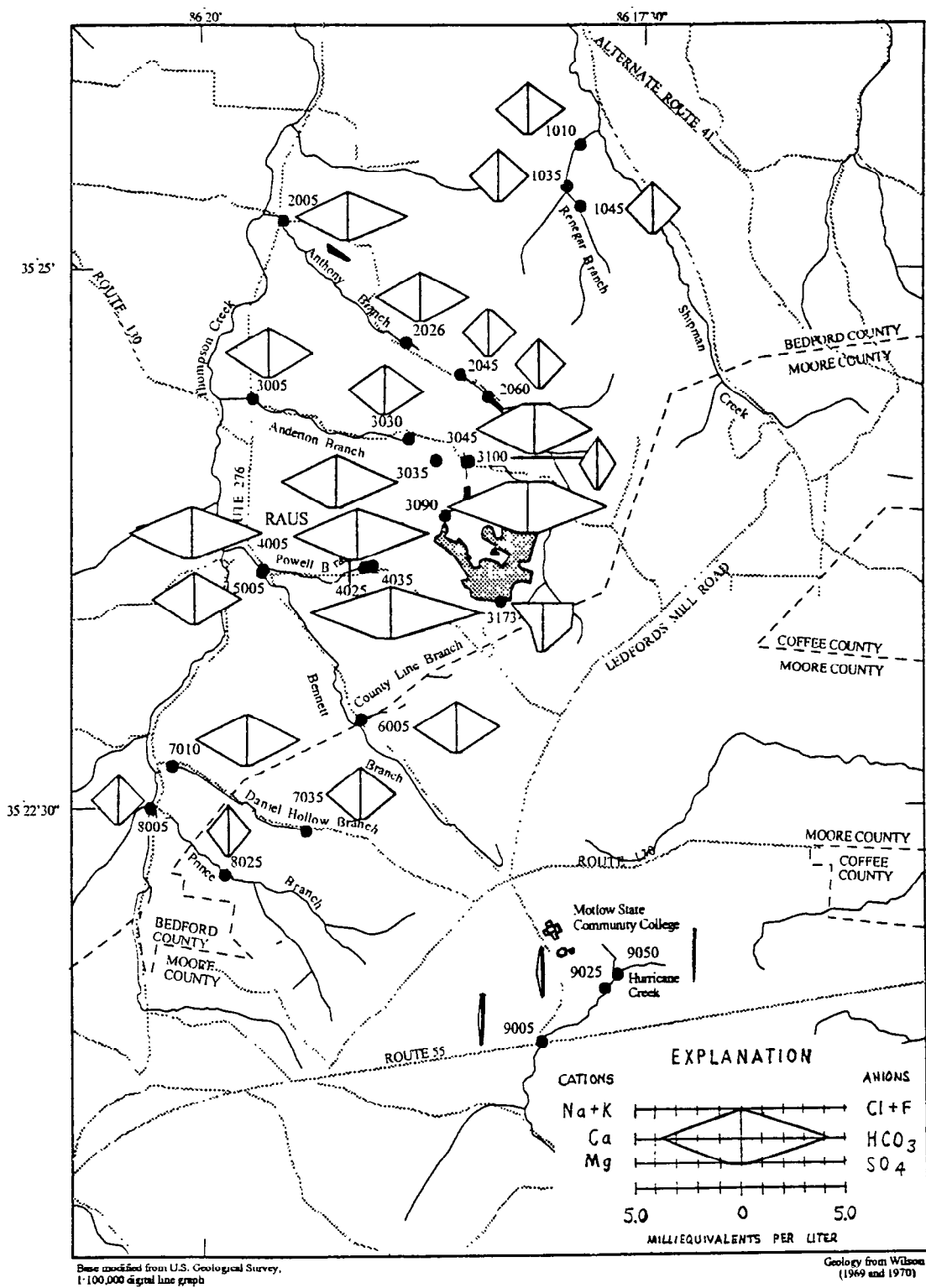


Figure 10. Stiff diagrams showing distribution of major constituents in water analyses from seepage investigation, Bedford and Moore Counties, Tennessee.

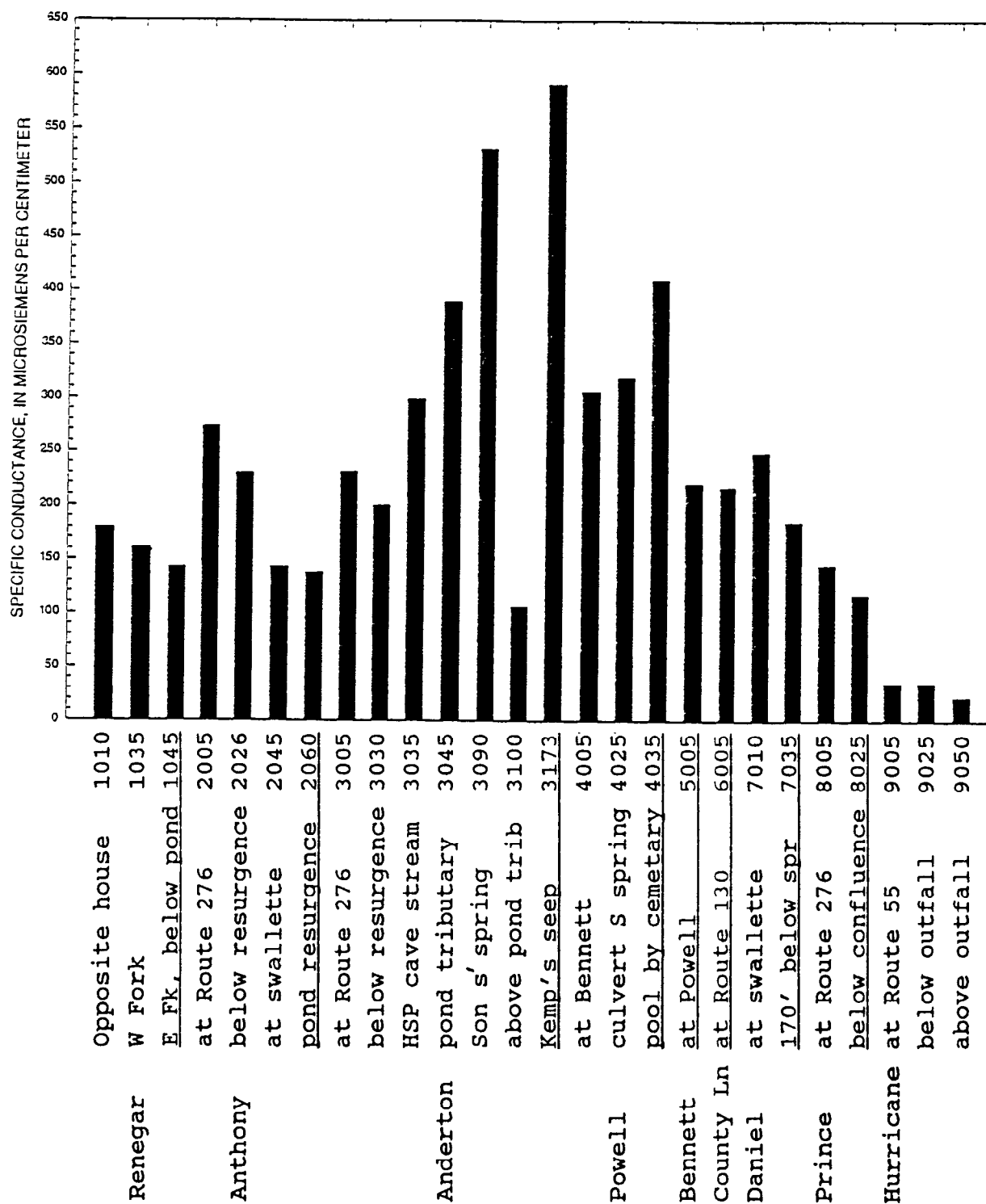


Figure 11. Specific conductance of water from the seepage investigation, Bedford and Moore Counties, Tennessee (see fig. 10 for site location).

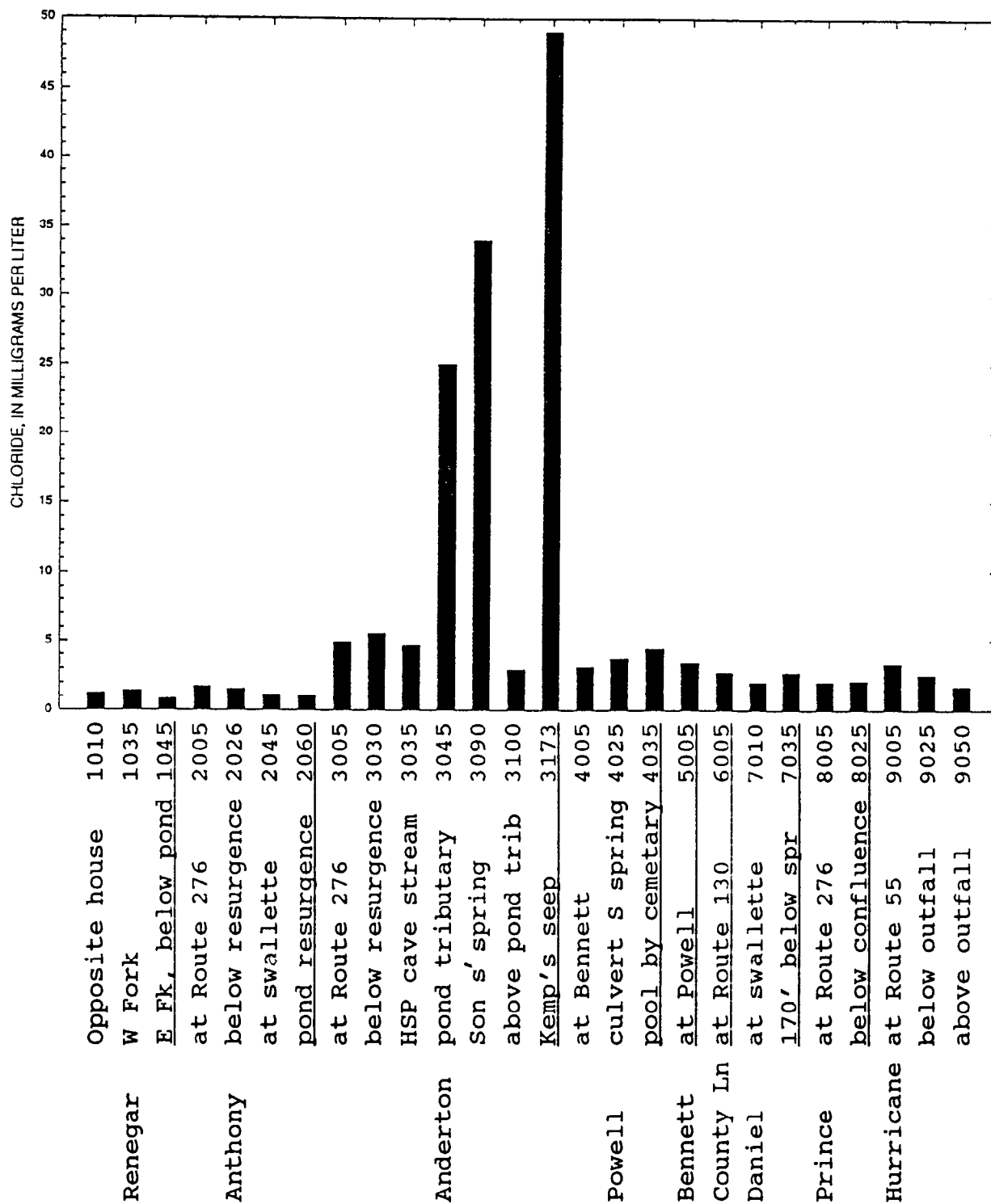


Figure 12. Chloride in water analyses from the seepage investigation, Bedford and Moore Counties, Tennessee (see fig. 10 for site location).

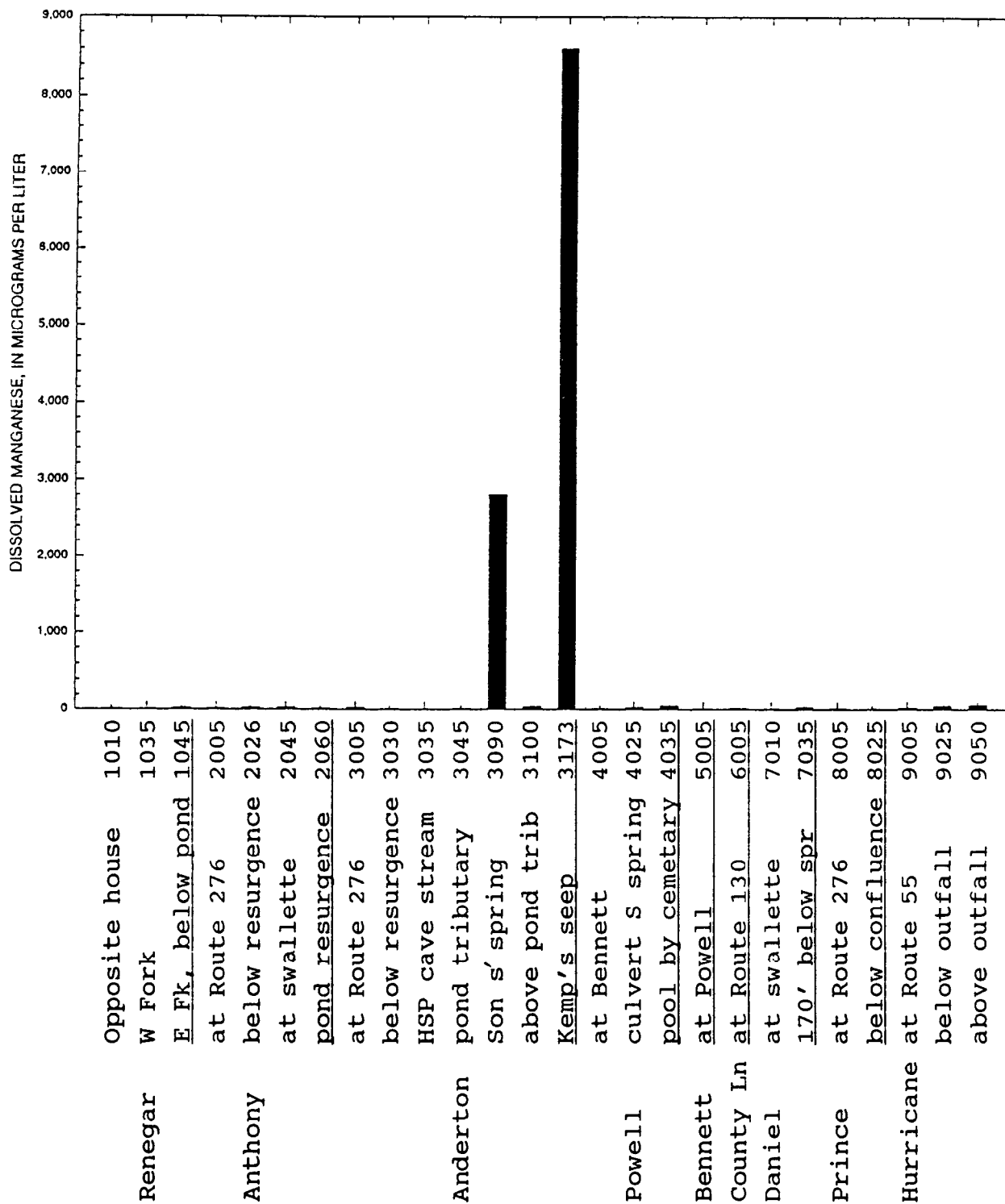


Figure 13. Dissolved manganese in water analyses from the seepage investigation, Bedford and Moore Counties, Tennessee (see fig. 10 for site location).

EXPLANATION

S Standard added to sample
prior to analyses

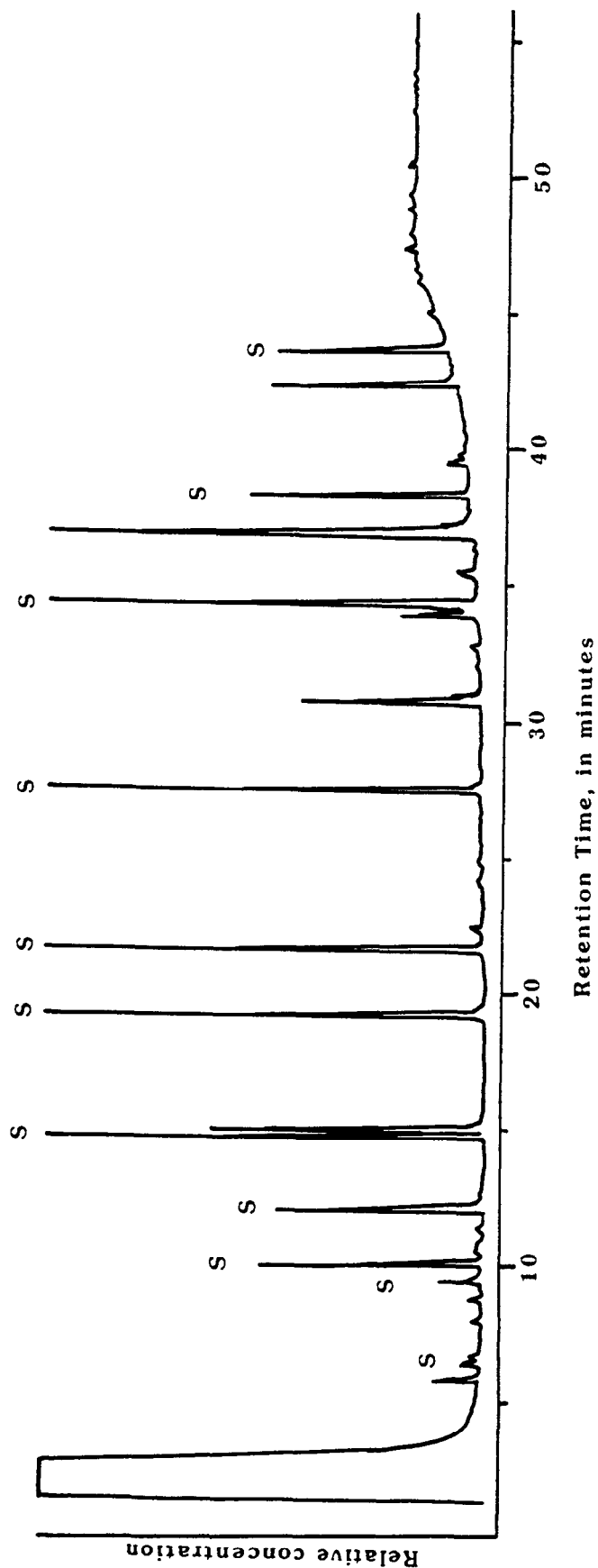


Figure 14. Gas chromatography/flame-ionization detection graph for site 1045, Renegar Branch, East Fork, Bedford County, Tennessee.

EXPLANATION

S Standard added to sample
prior to analyses.

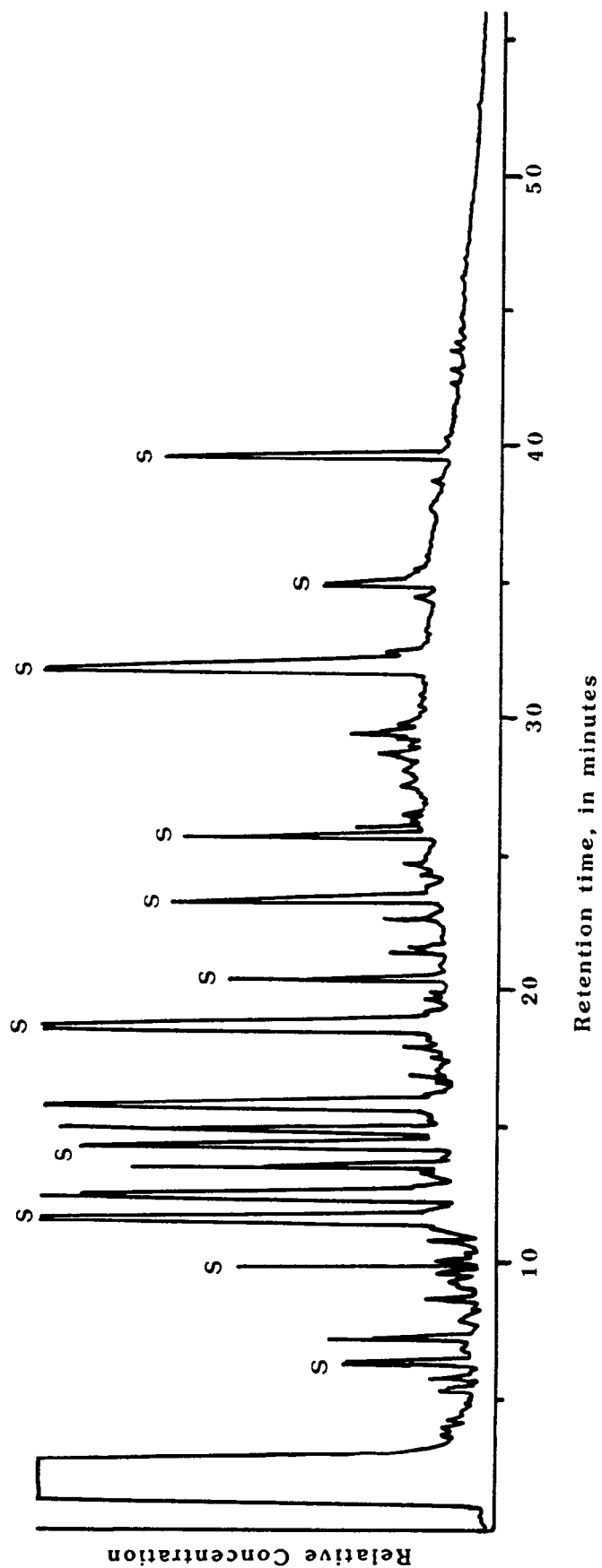


Figure 15. Gas chromatography/flame-ionization detection graph for site 3173, Kemp's Seep, Bedford County, Tennessee.

EXPLANATION

S Standard added to sample
prior to analyses

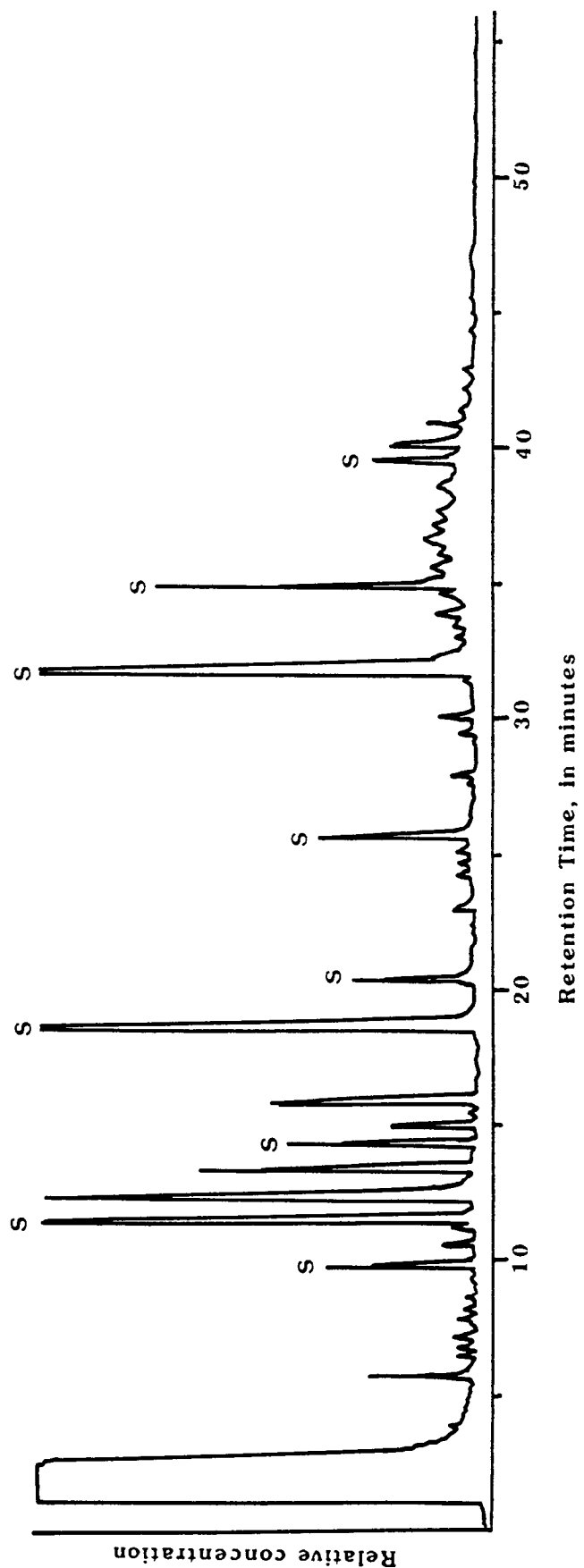


Figure 16. Gas chromatography/flame-ionization detection graph for site 3090, Sons' Spring, Bedford County, Tennessee.

37 unidentified organic compounds. The estimated concentrations ranged between 1 and 10 µg/L for 30 compounds, between 10 and 40 µg/L for 5 compounds, and between 60 and 100 µg/L for 2 compounds.

REFERENCES CITED

- Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chap. A8, 65 p.
- Miller, R.A., 1974, Geologic history of Tennessee: Tennessee Division of Geology Bulletin 74, 63 p.
- Tennessee Department of Environment and Conservation, 1994, Regulations for public water systems and drinking water quality, Chapter 1200-5-1: Tennessee Division of Water Supply, 207 p.
- Wilson, C.W., Jr., 1969, Geologic map and mineral resources summary of the Cumberland Springs (Lynchburg East) quadrangle, Tennessee: Tennessee Division of Geology GM 79-SE and MRS 79-SE, 1 sheet, scale 1:24,000.
- 1970, Geologic map and mineral resources summary of the Normandy quadrangle, Tennessee: Tennessee Division of Geology GM 79-NE and MRS 79-NE, 1 sheet, scale 1:24,000.
- Zurawski, Ann, 1978, Summary appraisals of the Nation's ground-water resources—Tennessee region: U.S. Geological Survey Professional Paper 813-L, 35 p.